INTEGRATION OF THE DISTRIBUTION
AND REPAIR IN VARIABLE ENVIRONMENTS
(DRIVE) MODEL INTO MICAP POLICY

THESIS

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AFIT/GLM/LAL/96S-1

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Preface

The purpose of this research was to compare different utilization levels of DRIVE using UMMIPS as a baseline for comparison. The results of this research may help Air Force decision makers and DRIVE users better understand the DRIVE model, and the ramifications of implementing DRIVE.

An extensive search of pertinent literature was done to learn about the DRIVE model and previous research on DRIVE. Desktop DRIVE version 5.0 was used to produce DRIVE decisions, and analytical Dyna-METRIC version 4.6 was used to evaluate the six different DRIVE implementation levels.

This research would not have been possible without the continued help of many Air Force Material Command (AFMC) people to whom I owe a great deal. I would also like to thank my advisors, Lt Col Jacob Simons and Major Terrance Pohlen, for their many hours of advice and guidance throughout the development of this thesis.

The completion of this thesis is due primarily to my sponsors Bob McCormick and Barb Wieland of AFMC who spent many hours educating, guiding, referring, and assisting me. Without their continued support this research would not have been possible.

I am also grateful beyond words to the two loves of my life, Jane and Tasha. Jane's support, understanding, and reassurance kept me on track, while Tasha's smiles and giggles always lifted my spirits and helped keep life in perspective.

Bradley E. Anderson

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Abstract

The United States Air Force has implemented the Distribution and Repair In Variable Environments (DRIVE) Model to a limited degree for a limited range of items, and policy makers seem unsure as to the proper level of DRIVE utilization. New asset release sequences and policies have been proposed without evidence to support those decisions. The purpose of this study is to explore different levels of DRIVE implementation relating to proposed asset release policies in order to provide some evidence on which policy could best support Air Force weapon systems. A second purpose of this study is to show how the DRIVE Model works in terms of asset distribution decisions.

The approach used in this research involved using the Uniform Material Movement and Issue Priority System (UMMIPS) as a baseline for comparison with DRIVE implementation. A historical requisition database was used in order to determine UMMIPS results, and to determine the actual allocated quantities of each asset during the two quarter period used for the comparison. The actual allocated quantities were then reallocated using five increasing levels of DRIVE implementation, resulting in a total of six research levels overall (including UMMIPS).

The research results yielded evidence that DRIVE utilization does increase aircraft availability for all locations as a whole and bases with a FAD of two (versus FAD one), although FAD one locations saw only a marginal decline in availability rates. Although

greater DRIVE implementation over current operations did not yield higher results, pure DRIVE utilization performed as well as current operating policy, and better than UMMIPS logic without any requisition data. Results provided evidence that the latest HQ USAF/LGSP proposed asset distribution policy produced worse results than current operating policy. DRIVE's asset distribution decisions produced the best overall results within the scope of this research, and warrants further study for even greater understanding of its capabilities and limitations.

INTEGRATION OF THE DISTRIBUTION AND REPAIR IN VARIABLE ENVIRONMENTS (DRIVE) MODEL INTO MICAP POLICY

I. Introduction

Chapter Overview

The Distribution and Repair in Variable Environments (DRIVE) method of prioritizing depot repair and distribution of parts was developed by the Rand Corporation and has been implemented within some Air Force organizations. Since DRIVE has proven promising in initial implementation (Miller and Abell, 1992), it is being considered by Air Force Materiel Command (AFMC) for more widespread use. DRIVE is based on the idea of ranking parts to be repaired based on their contribution to aircraft availability (AA). It prioritizes repair and allocates items to the end-users. This research addresses the impact of various levels of DRIVE implementation on United States Air Force Bases with different Force Activity Designator (FAD) Codes, focusing only on the distribution aspect of DRIVE. This chapter describes the general issues, background information, specific problem, purpose of the research, research objectives, research questions, hypotheses, methodology, assumptions, scope and limitations, significance of the research, and expected results.

General Issue

The Air Force has limited funding to buy and repair the assets required to keep aircraft flying, therefore the allocation of these limited resources is critical. The right part

needs to be where it's needed the most in the least amount of time. DRIVE was developed as an alternative approach for managing the repair and distribution of aircraft recoverable assets at depots (Abell and others, 1992). DRIVE's objective function is oriented toward aircraft availability versus the traditional performance measures such as mission capable (MICAP) or awaiting parts (AWP) parts. This shift in emphasis is not yet fully understood or accepted within the Air Force; therefore, increased understanding of how DRIVE works and the results it produces are necessary before DRIVE's appropriate level of implementation can be properly decided.

Background

The Air Force has adopted a philosophy of logistics operations directed toward improving the products, costs, and responsiveness of the Air Force's reparable pipeline. The philosophy is termed Lean Logistics (LL). AFMC proposed LL in response to budget cuts and force reductions in order to improve efficiency and cost effectiveness (Ferris, 1995). The Air Force uses the term LL to refer to its adaptation of lean production -- the innovative logistics practices used in commercial logistics. It proposes utilizing fast transportation, consolidating supplies at intermediate locations, streamlining repair processes at depots, and involving customers in the process of meeting their own needs. These practices are currently being pursued, except for the use of intermediate storage locations. Many traditional logistics processes within the Air Force are changing due to the implementation of LL (Lynch, 1994).

The traditional depot repair management system is not sensitive to the evolving asset position, nor does it incorporate explicit consideration of aircraft availability goals in repairing or allocating assets. During the fiscal quarter in which component repairs occur, the asset data underlying the estimation of repair requirements for that quarter are six to nine months old. The repair goals toward which the depot maintenance activity works are negotiated internally between functional entities within the Air Logistics Center (ALC). The goals are frequently adjusted during the quarter, typically downward, usually due to shortages of repairable carcasses or repair parts, owing to the failure of the current system to take explicit account of uncertainty in its repair-requirements determination process (Abell and others, 1992).

DRIVE was developed as an alternative to the current system and takes a very different approach to the problem. It uses a current snapshot of the asset position (no more than a couple of days old at the time the algorithm is run), coupled with aircraft availability goals (Abell and others, 1992). User specified scenario data (goals, force beddown, flying hours, etc.) are combined with data elements from several standard AFMC data systems to support DRIVE's decision making about prioritization of repairs within repair resources and the allocation of serviceable assets to locations worldwide (Miller and Abell, 1992). DRIVE uses the forecasts of bases' demands for assets during the planning horizon to specify parameters of probability distributions that are the basis of the computations in the prioritization algorithm. The goals of DRIVE are to prioritize repair and to allocate items in such a way as to obtain the greatest weapon system availability (Lindenbach and others, 1992). The DRIVE model recommends allocation of

reparables to many different locations as opposed to a single location. DRIVE takes into account projected flying hours, part failure rates, indentured items (items having other reparables as sub-components), repair capabilities at the bases and depots, and the number of serviceables at each location to determine reparable allocations (Ferris, 1995).

DRIVE has already been implemented within some AFMC organizations. The prototype of DRIVE was developed and demonstrated at the Ogden ALC in 1992. DRIVE has been implemented for regular use at both depot and base levels for specific National Stock Number (NSN) items for certain weapon systems. AFMC programs such as the Execution and Prioritization of Repair Support System (EXPRESS) and Distribution '97 look to apply DRIVE even further. EXPRESS is a combination of DRIVE and LL which is being examined by the AFMC Requirements Team based at Oklahoma City ALC, OK. EXPRESS utilizes DRIVE as a depot repair prioritization tool. Distribution '97 employs DRIVE as an asset release prioritization tool, and is being considered by the AFMC Stock Control Team, based in San Antonio, TX, for widespread depot use (McCormick, 1995).

Specific Problem

DRIVE has been implemented only to a very limited degree within the Air Force with tight constraints over its application. Previous studies have shown results which provide evidence that DRIVE would produce better results at distributing assets for a weapon system, as a whole, across similar bases than the current system. The ramifications of increased implementation and less constrained use of DRIVE to

organizations with different priorities (FADs) is not fully understood. This problem is made more apparent by the establishment of a priority asset release sequence by HQ USAF/LGSP which will distribute assets for all MICAP requisitions in Uniform Material Movement and Issue Priority System (UMMIPS) sequence before DRIVE logic is to be utilized. This effectively utilizes DRIVE for only low priority requisitions (below MICAP priority).

The problem addressed in this thesis: What level of DRIVE implementation, if any, is most appropriate in supporting weapon system users? The overall research question addressed in this thesis: Does the increased implementation and, therefore, less constrained use of DRIVE (versus the use of UMMIPS) result in more or less support (in terms of AA) to high or low priority locations (in terms of FAD)?

Purpose of Research

The purpose of this study is to compare six implementation levels of decreasingly constrained/increased DRIVE utilization in order to ascertain the change in logistical support provided to locations of differing priority (FAD).

Research Objectives

There are three goals of this research:

1) To compare recently utilized or proposed asset allocation policies (mixes of the UMMIPS and DRIVE models) to see which best supports the line-replaceable unit (LRU) using organizations and how much of a difference, if any, exists between these policies.

2) To either support or refute previous research pertaining to comparisons of UMMIPS and DRIVE.

3) To add the dimension of different priority locations (including FAD one) to the research design in order to address any change in asset support which may occur to different priority locations due to increased implementation of DRIVE.

These goals are meant to assist Air Force decision makers in determining the appropriate Air Force level and application of DRIVE implementation.

Research Questions

The following specific research questions were developed to support the comparison of the DRIVE implementation levels:

1. How does each DRIVE implementation level perform in terms of overall level of logistical support?

a) Which implementation level results in the highest overall projected aircraft availability?

b) What are the differences among the overall projected aircraft availability rates for each implementation level?

2. How does each DRIVE implementation level perform in terms of logistical support for each location (air force base)?

a) Which implementation level results in the highest projected aircraft availability for each location?

b) What are the differences among projected aircraft availability rates between each implementation level for each location?

c) What is the range between projected aircraft availability rates within each implementation level?

3. How does each DRIVE implementation level perform in terms of logistical support for locations (bases) with different FADs?

a) Which implementation level results in the highest projected aircraft availability for locations with the same FAD?

b) What are the differences among projected aircraft availability rates between each implementation level for locations with the same FAD?

c) What are the differences among projected aircraft availability rates between locations with different FADs within each implementation level?

Research Hypotheses

The following non-statistically based hypotheses were developed for this research:

1) In order to answer the first research question, the null hypothesis to be tested is: Projected overall aircraft availability (A) of level x is equal to the projected overall aircraft availability of level x + 1.

H_o: $A_x = A_{x+1}$

H_a: $A_x \neq A_{x+1}$

where A_x equals the projected overall aircraft availability of implementation level x, and A_{x+1} equals the projected overall aircraft availability of the next increased DRIVE utilization level.

2) In order to answer the second research question, the null hypothesis to be tested is: The minimum projected aircraft availability of level "B" is equal to the maximum projected aircraft availability of level "B".

H_o: $B_{min} = B_{max}$

H_a: $B_{min} \neq B_{max}$

where B_{min} equals the minimum projected aircraft availability of all research locations for implementation level B, and B_{max} equals the maximum projected aircraft availability of all research locations for implementation level B.

3) In order to answer the third research question, the null hypotheses to be tested are:

a) Average projected aircraft availability of level x for Bases with FAD "F" is equal to the projected aircraft availability of level x + 1 for Bases with FAD "F".

H_o: $F_x = F_{x+1}$

H_a: $F_x \neq F_{x+1}$

where F_x equals the average projected aircraft availability of implementation level x for bases with FAD F, and F_{x+1} equals the average projected aircraft availability of the next increased DRIVE utilization level at bases with FAD F.

b) Average projected aircraft availability of level x for Bases with FAD "F" is equal to the average projected aircraft availability of level x for Bases with FAD "G".

H_o: $F_x = G_x$

H_a: $F_x \neq G_x$

where F_x equals the average projected aircraft availability of implementation level x at bases with FAD B, and G_x equals the average projected aircraft availability of the same implementation level at bases with FAD G.

Methodology

Six C-130H LRUs, which are critical items to the greatest number of locations, will be compared over six decreasingly constrained DRIVE implementation levels to see whether increased implementation of DRIVE results in changed projected AA rates for organizations with different FADs. The results will be compared in terms of percent change in AA. MICAP requisitions will be focused on since they represent the items which drive AA most, and because allocation policies and release sequences to fill MICAPs have recently been the most debated aspects regarding DRIVE implementation and asset allocations.

Assumptions

The analysis of this research adopts the following assumptions:

1) The selected C-130H LRUs represent the entire weapon system and solely affect the weapons system's projected AA rate. Only 10 LRUs (six NSNs will be used in the research) will be initially selected to enable a reasonably scaled study. These items will be

problem/critical items for the largest number of organizations; therefore, they would be expected to drive AA to a much higher magnitude than other LRUs.

2) The time period selected from which the data was obtained is representative of "normal" activity and capabilities. Activity and capabilities vary from period to period depending on many factors, but do not vary substantially on the same weapon system for a similar level of activity over the short term.

3) Projected aircraft availability can effectively be determined in terms of projected non-mission capable-supply (NMCS) aircraft only. This is a necessary assumption because Dyna-METRIC evaluates AA based on NMCS rates.

4) UMMIPS distributions would be made as indicated in the regulations. This assumption is needed, since possible Item Manager (IM) intervention is not being considered.

5) All requisitions were valid. Any invalid requisitions could alter results of the models' asset allocations.

6) The following assumptions are necessary in order to use the DRIVE model, since DRIVE is based upon them:

a. The data is accurate.

b. Shop-replaceable unit (SRU) repair parts are in stock.

c. Base cannibalization; holes instantly consolidated on as few aircraft as possible.

d. Each item has one primary repair shop.

e. Only Sub-Group Master Stock Numbers are considered.

f. The probability that a given number of LRU not repairable this station (NRTS) actions will occur at a base during the planning horizon comes from a negative binomial probability distribution.

Scope and Limitations

This research is limited to an analysis of C-130 support for Air Force Bases, based on selected LRUs over a two quarter period, during peacetime. These limitations were necessary in order to keep the scope of the research manageable, but should provide a solid base of information due to broad applications of the C-130H weapon system. Two quarters of data provide a good pool of assets and requisition data for the analysis, and peacetime was chosen since that is current Air Force status. Many other weapon systems, parameter settings, and periods are worthy of study, but the factors used for this research are best for answering the research questions of this thesis.

Some of the possible confounding variables or sources of error which may limit the results of the research are:

1) The assumptions stated above may be violated.

2) Dyna-METRIC version 4.6 analytical was utilized in projecting AA results, therefore parametric statistical analysis is not appropriate.

3) The single weapon system data used may not be representative of other weapon system's data.

4) Circumstances which exist at each location at the beginning of the period from which data was obtained are uncontrolled and may be "uncharacteristic" of "normal" operations and capabilities.

5) Different circumstances and capabilities at different locations, such as repair capabilities, primary assigned aircraft (PAA), and location, introduce confounding variables which may affect comparisons between different locations.

Significance of Research

The reluctance on the part of many organizations to accept DRIVE seems to be motivated primarily by a perceived loss of advantage, due to the fact that DRIVE, in its unconstrained form, doesn't consider location priority (FAD). This research is meant to be an extension of previous research (Neumann and all, 1992; Culosi and Eichorn, 1993) by showing the effect that increased or full DRIVE implementation would be expected to have on priority organizations, using existing AA goals. The research results are meant to aid United States Air Force policy makers in choosing the best level of DRIVE model implementation, in respect to asset distribution, for the future of logistics support within the United States Air Force.

Expected Results

Greater utilization and less constrained use of DRIVE would be expected to result in higher overall weapon system availability (across all bases), but reduced AA for the higher priority locations' (FAD one bases). This is expected due to DRIVE's objective of

maximizing AA over a group of locations as a whole, and because the current DRIVE AA goals give no preferential treatment to bases with a higher FAD when DRIVE is run unconstrained. Whether priority locations will actually have reduced expected AA rates with greater DRIVE utilization is uncertain, and is the reason for this research.

Chapter Summary and Organization of Research

This thesis consists of six chapters. Chapter one presented the general issues surrounding the research and the problem of selecting the appropriate level of DRIVE implementation. This chapter also described relevant background information, the purpose of the research, research objectives, research questions, the research hypotheses relating to the research questions, methodology, assumptions, scope and limitations of the research, the significance of the research, and expected results.

Chapter two describes the DRIVE model, and goes into detail on the DRIVE algorithm. The overall DRIVE system, functions and input data, and DRIVE products are briefly described. The majority of the chapter involves DRIVE calculations, such as intermediate calculations and the algorithm.

Chapter three is a literature review which describes previous research on DRIVE implementation. It describes two Rand reports on DRIVE implementation at Ogden ALC which give information on the origins and basics of DRIVE. It also introduces AFMC and LMI studies which give the foundation for research involving comparisons of UMMIPS logic and the DRIVE model and which helped guide the research methodology.

Chapter four discusses the research methodology of this thesis. The research questions developed to support the comparison of the DRIVE implementation levels are discussed in detail. The methodologies of data selection and asset allocation for each research level are also explained.

Chapter five presents the results and analysis of the data collected. The research results yielded evidence that DRIVE utilization does increase aircraft availability for all locations as a whole and bases with a FAD of two (versus FAD one), although FAD one locations saw only a marginal decline in availability rates. Other comparisons such as the range of rates and differences between different levels and different bases are also examined.

Lastly, chapter six provides conclusions and recommendations derived from the research. Although greater DRIVE implementation over current operations did not yield higher results, pure DRIVE utilization performed as well as current operating policy, and better than UMMIPS logic without any requisition data. Results provided evidence that the latest HQ USAF/LGSP proposed asset distribution policy actually produced worse results than current operating policy. Other Air Force implications and recommendations for further study are also discussed in Chapter VI.

II. The DRIVE Model

Chapter Overview

In the 1980s, the Air Force recognized the need to be more responsive to quickly changing military scenarios. The Air Force also realized the need for an intelligent method of distributing available items of supply among potential customers. The Distribution and Repair in Variable Environments (DRIVE) system is an Air Force initiative designed to improve depot responsiveness to current and near-term operational requirements, both in peacetime and wartime. DRIVE originated from Rand's Uncertainty Project which quantified the levels of variability in demand for aircraft recoverable spare parts observed during peace-time. It is a set of computations designed to provide the greatest "bang for the buck" for the Air Force by repairing the most needed assets, then distributing them to those customers which will create the highest possible overall aircraft availability rate (within constraints) to support the Air Force mission.

This chapter consists of five main sections:

1) The DRIVE System
2) DRIVE Functions and Input data
3) Intermediate Calculations
4) The DRIVE Algorithm
5) DRIVE Products

This chapter consolidates information written on DRIVE by AFMC and Rand. Although the information presented is a mixture of the references listed, the sections on DRIVE calculations, the DRIVE algorithm, and the DRIVE objective function (Appendix B) were

extracted from the article "Distribution and Repair In Variable Environments (DRIVE) Model Logic" by Richard Moore and Bob McCormick (McCormick and Moore, 1992).

Section 1 - The DRIVE System

The Weapon System Management Information System (WSMIS) is a decision support system that assesses logistics support, focusing on weapon system availability. DRIVE makes up two modules within WSMIS; D087J (Classified DRIVE) and D087K (Unclassified DRIVE). DRIVE extends the WSMIS approach of logistics capacity assessment to the Air Logistics Center (ALC) level by defining repair and distribution priorities, based on elements such as aircraft availability goals, planned flying hours, and worldwide asset position (see Figure 2-1 below).

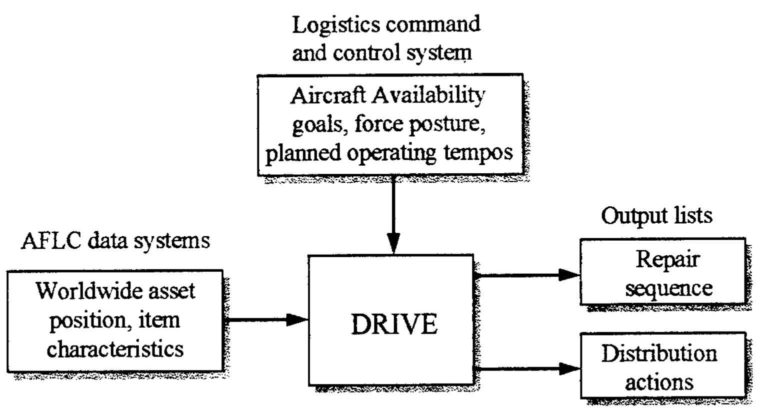

Figure 2-1. Basic DRIVE Architecture (Abell and others, 1992)

DRIVE prioritizes the repair of exchangeable items (Line Replaceable Units (LRU) and Shop Replaceable Units (SRU)) so the greatest increase in base level weapon system availability is achieved per repair resources expended. Once assets are made serviceable,

DRIVE identifies the location to which each serviceable should be shipped to achieve the greatest probability of achieving weapon system availability goals. This approach yields the best possible depot support to meet changing operational requirements within available resources and across short planning horizons.

Desktop DRIVE is a microcomputer based application of classified DRIVE that supports Forward Depot, Regional Repair Center (RRC), and secondary source of supply operations, automated distribution, leveling, and what-if analysis. It supports and augments the AFMC DRIVE mainframe system operating at HQ AFMC, Wright-Patterson AFB. It was originally conceived as an analysis tool to support the AFMC DRIVE development effort and is still utilized in this manner. Desktop DRIVE is utilized as the analysis tool for this thesis. In addition, Desktop DRIVE supports Air Force Units such as the Forward Depot at Kadena AB and RRC operations at Tinker AFB. Desktop DRIVE receives input data files from Classified DRIVE (D087J), D035A, D035K, D035C, and G402A. These input files are downloaded from their respective systems to diskettes and then loaded into Desktop DRIVE. Desktop DRIVE facilitates the user's analysis by partitioning the AFMC classified DRIVE database into smaller unclassified subsets of data.

Section 2 - DRIVE Functions and Input Data

WSMIS DRIVE can be divided into five distinct functions which are performed within a DRIVE cycle:

1) Data collection and loading
2) File maintenance

3) Model input creation
4) Model output loading
5) Output reporting

1) Data collection and loading. The data collection and loading function is a set of software modules that process AF data system inputs to DRIVE. Memoranda of Agreement (MOAs) were negotiated to provide data to DRIVE on a scheduled basis. The data arrives on a daily to quarterly basis, depending on the source.

2) File maintenance. On-line file maintenance can be performed by the DRIVE system user with appropriate access privileges. The current data can be viewed or modified through a series of on-line screens.

3) Model input creation. The preparation of Unclassified DRIVE data for transfer to the classified model is a background process triggered periodically. This process consolidates data from the Unclassified DRIVE database, formats it for the model, allows for some final file maintenance, and writes the data to magnetic tape for processing by Classified DRIVE. The data preparation process generates the Maldistributed Stock Report, identifying repairable stock quantities located at Stock Record Account Numbers (SRANs) at which the item's Mission-Design-Series (MDS) is not flown.

4) Model output loading. Classified DRIVE transmits data from the model to Unclassified DRIVE. Four physical files are passed back to Unclassified DRIVE from Classified DRIVE; the parameter file, audit file, maldistributed stock file, and compout lists file. This data is loaded into the Unclassified DRIVE data base by background batch jobs, which include the application of available resources against the compout lists file.

The compout lists file is the model output file which is used by desktop DRIVE to produce reports.

5) Output reporting. Production of reports for the DRIVE users is the final function within a DRIVE cycle. Unclassified reports are produced by the Unclassified DRIVE Mainframe and DRIVE distribution module (DDM). Some reports are distributed automatically, while others are requested on-line.

DRIVE model input data supports one of two purposes. One purpose is to measure the needs of item users, and the other is to determine how best to supply those needs. Users are Air Force Bases, Foreign Military Sales (FMS) customers, other services and agencies, and the ALC. A user is anyone who requisitions Air Force managed recoverable items. The DRIVE model forecasts usage (expected demands) for those Air Force users with flying programs. For Air Force Base additive requirements (those over and above what the flying program supports), FMS, Programmed Depot Maintenance and engine overhaul, and other service users DRIVE accepts externally computed values for expected future demands (see Figure 2-2).

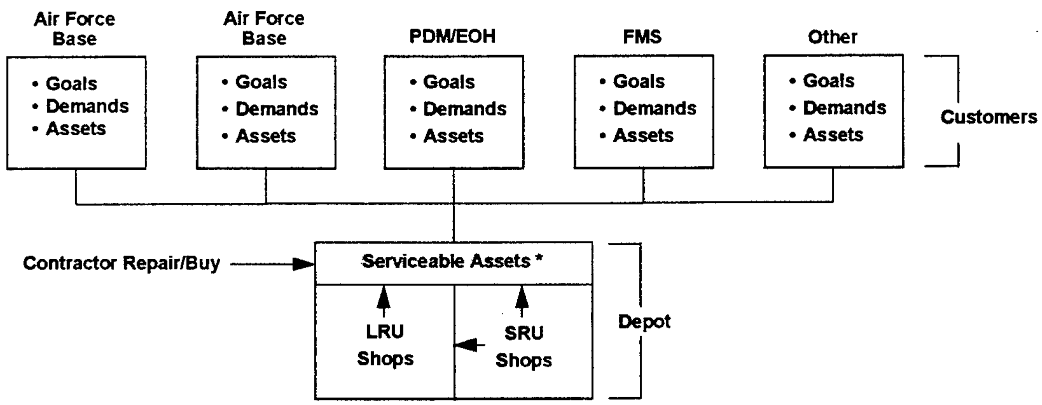

Figure 2-2. DRIVE Model View of the World
(AFMC DRIVE User Training, Module I, 1994)

DRIVE considers three sources of demand data. The first source is computed for Air Force users with flying programs. The calculation, multiplied by a set of demand and application factors, provides the expected need DRIVE seeks to satisfy. It is one of the most significant inputs to the prioritization process. Another set of demand computations are done prior to the model and are called non-Primary Authorized Aircraft (PAA) demands. FMS demands and depot overhaul demands are included in this category. The depot overhaul needs are computed in the DRIVE unclassified system preprocessor from planning data. Sufficient data is not available for other types of non-PAA demands, so the model converts these values to expected demands consistent with the Air Force program computed values. The last set of demands are depot SRU generations. These are the broken items expected to occur during depot LRU repair. They are computed as number

of LRUs repaired multiplied by the SRU replacement fraction, and are used in determining how much support to give the depot.

Section 3 - Intermediate Calculations

Before DRIVE assigns the ranking measure, or sort value, to each repair and distribution transaction some intermediate computations are needed to transform the input data into a form which the prioritization process can use. There are two main types of calculations to discuss. The first is devoted to the calculations, mentioned above, to transform the data. The second type are extra calculations DRIVE makes for common items because the model processes one LRU at a time.

The prioritization approach used by the DRIVE algorithm and objective function first determines the number of LRU failures the base can experience during the planning horizon without preventing it from meeting its availability goal. The likelihood of not exceeding that amount of failures is then computed. The following input data are needed for the computation:

1. Stock
2. Holes
3. Quantity Per Application (QPA)
4. Expected NRTS
5. Allowable Holes

1. Stock. This data is needed for each item in the LRU family for each base. It includes all serviceables on-hand and in-transit for LRUs and SRUs, as well as the non-AWP Due-In From Maintenance (DIFM) for Remove and Replace (RR) War Readiness Spares Kit (WRSK) base LRUs. The first step is to determine the non-AWP DIFM assets

to consider as serviceable. For bases with no WRSK/Base-Level Self-Sufficiency Spares (BLSS) or with RRR WRSK/BLSS (they have repair during the surge period), no DIFM assets are considered serviceable by the model. This is because each base has a base repair pipeline which the model assumes to be fairly constant over a short time period. The exception is RR WRSK/BLSS bases. These units have LRUs only in their kits and no surge repair, therefore no surge base repair pipeline, so the model assumes that the non-AWP DIFM assets will be returned to serviceable condition prior to the surge period. After non-AWP DIFM is determined, the model combines the serviceable asset balances for each base. The calculation is:

$$\text{Stock} = P + W + S + D$$

where, P = D035C Primary Operating Stock (POS) serviceable balance
W = D035C War Reserve Material (WRM) serviceable balance
S = Serviceable In-transit (SIT) balance
D = DIFM - AWP balance at RR WRSK bases or 0 for other bases

2. Holes. This is needed for each item in the LRU family for each base. It is the quantity of items missing from the next higher assembly. This is the MICAP quantity for LRUs and AWP quantity for SRUs.

3. QPA. This is needed for each LRU and SRU for each MDS application.

4. Expected NRTS. This is needed for each item in the LRU family for each base. Expected base condemnations are also included, but, for simplicity, these will be referred to as NRTS. It will be computed using the following data elements: scheduled flying hours during the planning horizon, item quantity per application (QPA), item application

percent (FAP), item demand rate, item NRTS rate, and item condemnation rate. The NRTS plus condemnations value gives the total need that the depot will be expected (without safety level) to supply. This value is computed across the peace horizon and surge period if the unit has a WRSK/BLSS authorization. The peacetime and surge portions are treated separately as some factors may vary. These calculations are done for each unit-MDS combination and summed up to provide a total base number.

Peace 'NRTS' = PFH * PDR * Q(M) * FAP(M) * (1 - PBR%)

where, PFH = Flying hours during the peace horizon for the MDS-unit from the DRIVE Scenario Subsystem.
PDR = Peace demand rate (normally from D041)
Q(M) = Quantity per application of this National Stock Number (NSN) on the MDS
FAP(M) = Percentage of MDS' in the unit containing this NSN
1- PBR% = NRTS% + Base Condemnation%. This represents the percentage of demand which the depot must supply (normally from D041)

War 'NRTS' = WFH * PDR * Q(M) * FAP(M) * (1 - WBR%)

where, WFH = Flying hours during the surge horizon for the MDS-unit (usually 30 days; from the DRIVE Scenario Subsystem)
PDR = Surge demand rate (normally from WSMIS/Sustainability Assessment Model (SAM))
Q(M) = Quantity per application of this NSN on the MDS
FAP(M) = Percentage of MDS' in the unit containing this NSN
1- WBR% = War NRTS% + Base Condemnation% (this represents the percentage of demand which the depot must supply; normally from WSMIS/SAM)

5. Allowable Holes. This data is needed for the LRU for each base. It is an item representation of the availability goals and assumes full cannibalization. It will be computed using the following data elements: primary authorized aircraft (PAA),

availability goals, QPA, and FAP. It provides the number of aircraft 'holes' which still allow enough available aircraft to meet the availability goal. It is computed for each LRU as of the end of peace periods and, if the unit has a WRSK or BLSS, surge periods. This is computed for each unit-MDS combination and summed up to give a base total.

Peace Allowable Holes = PPAA * QPA * FAP * (1 - G%)

where, PPAA = Peace Primary Authorized Aircraft
QPA = Quantity of this NSN on the MDS
FAP = Percentages of MDS' in the unit containing this NSN
(1 - G%) = Percentage of airplanes which can be 'down' and still allow goals to be met (Goal is the peace goal)

War Allowable Holes = WPAA * QPA * FAP * (1 - G%)

where, WPAA = WRSK/BLSS Primary Authorized Aircraft
QPA = Quantity of this NSN on the MDS
FAP = Percentages of MDS' in the unit containing this NSN
(1 - G%) = Percentage of airplanes which can be 'down' and still allow goals to be met (Goal is the surge goal)

The allowable holes value DRIVE uses for a base depends upon the units at the base. For units without a WRSK or BLSS kit, the peace value is used. For those units with a WRSK or BLSS kit, the war value is used. Since DRIVE is looking across peace and war, an extra check is made for bases which have a WRSK or BLSS kit(s). With some combinations of high QPA and availability goals, the probability of meeting the wartime goal could potentially be higher than the probability of meeting the peacetime goal. This could occur for high QPA items and is attributable to the full cannibalization assumption. The model checks for this condition and adjusts the war allowable holes, if necessary, to

ensure that the probability of meeting the goal at the end of the war planning horizon is no higher than at the end of the peace planning horizon.

The probability that a base will meet its availability goal at the end of the planning horizon is the probability that it experiences less than or equal to "F" failures, where "F" equals the allowable holes for an LRU plus its stock. This value is determined in the prioritization process.

One additional computation is the number of unserviceables expected to be generated by the bases and sent to the depot. This does not play in the prioritization algorithm directly but it is used when carcass constraints are considered. It is the sum of the peacetime NRTS (not including base condemnations as the demand computation does) from each base minus the expected depot condemnations.

Expected Carcasses = Total Base NRTS * (1 - Depot Condemnation %)

LRU Processing. DRIVE processes one LRU family at a time. Common items which are part of more than one LRU family require an adjustment to some of the inputs prior to the prioritization process. Essentially, these values are prorated to each family based on the expected need for the item in the family. This proration occurs for both base and depot data. The prorated base quantities are:

1. LRU and SRU serviceables
2. SRU Holes in LRUs.
3. LRU and SRU Non-PAA Demands.

The allocation weight for each item is computed for its use in each LRU family. It is the expected NRTS for the item, by base, from its use in that family, and is computed as described in the Expected NRTS section above. An allocation percentage is computed by dividing the allocation weight for the item by the total expected NRTS from the base. An example for NSN A at a base would be:

LRU Family	Allocation Weight	Allocation Percentage
1	10.0	10.0/20.0 = 50%
2	8.0	8.0/20.0 = 40%
3	2.0	2.0/20.0 = 10%

	Total = 20.0	

For LRU Family 1, 50% of the base serviceable assets (LRU or SRU depending on the item), SRU holes (if this is a SRU), and non-PAA demands will be allocated to the family. Similarly, 40% goes to LRU Family 2 and 20% to LRU Family 3 for NSN A.

A similar proration is done for some depot values. The allocation process is the same but the weights are computed differently for SRUs:

1. LRUs: The weight is the sum of all base NRTS during the planning horizon for the LRU.
2. SRUs: The weight includes all NRTS during the planning horizon plus expected SRU generations during the depot repair of the LRU.

These values provide the item's total expected demands on the depot during the planning horizon.

Section 4 - The DRIVE Algorithm

The DRIVE algorithm is the heart of the prioritization process. This is the part of the model which uses the values from the intermediate computations and produces the lists included in the DRIVE system's output products. The prioritization process consists of three steps when processing each LRU family:

Step 1 - The initial probability computation
Step 2 - The 'matching' of stock to holes to determine available assets to meet the availability target
Step 3 - The actual computation of the ranking measure called the sort value (this is done in three phases)

(* Appendix B, on the DRIVE objective function, provides more information on the sort value computation.)

Step 1. The model first computes the probability distribution for the NRTS from each base for each item using the expected NRTS as the mean. The distribution is assumed to be a negative binomial with the variance-to-mean ratio (VTMR) given by the Sherbrooke power formula (a = 0.14, b = 0.50). The model uses this probability distribution to predict the number of failures during the planning horizon.

Step 2. Next, the model adjusts the stock and holes for the LRU family so that at least one of these data elements is zero. Additionally, the model assumes that SRUs will be cannibalized across LRUs to minimize the number of AWP LRUs. These two assumptions can lead to more serviceable LRUs being made available. To see this, consider the following example of an LRU with two SRUs, SRU 1 and SRU 2:

	LRU	SRU 1	SRU 2
QPA =	1	2	1
stock =	0	3	4
holes =	2	5	2

The model would assume that there are currently 3 AWP (i.e., the 5 holes of SRU 1 will be consolidated onto 3 LRUs since the QPA is 2; the 2 holes of SRU 2 will be on 2 LRUs since its QPA is 1, but these 2 LRUs are assumed to be 2 of the 3 LRUs that are AWP due to SRU 1; so, there are only 3 AWP for these 2 SRUs). After applying stock to holes the picture looks like this:

	LRU	SRU 1	SRU 2
QPA =	1	2	1
stock =	0	0	2
holes =	0	2	0

The 3 serviceables for SRU 1 were put onto 3 of its 5 holes, so its updated picture is 0 stock and 2 holes. Similarly for SRU 2, 2 of the 4 serviceables were put onto its 2 holes, so its updated picture is 2 stock and 0 holes. So, now there is 1 AWP (i.e., the 2 holes of SRU 1 will be consolidated onto 1 LRU since it's QPA is 2). Since there were 3 AWP initially and there is now 1 AWP, 2 LRUs were fixed. These 2 serviceable LRUs are put onto its 2 holes to leave 0 stock and 0 holes. (Note that 2 MICAPs were able to be satisfied without any depot support.) The model uses this adjusted base asset picture as the asset position going into the optimization for the LRU family at the bases.

Step 3. Here, the model begins the optimization. There are three phases/classes of allocations that DRIVE makes during the optimizations:

Phase 1 - Allocations to satisfy MICAPs
Phase 2 - Allocations to bases in poor asset position
Phase 3 - Standard allocations

Phase 1 - Allocations to Satisfy MICAPs

DRIVE will attempt to satisfy all MICAPs at the bases first (if run constrained to do so). If there are any, the model will compute the need for each of the bases with MICAPs and choose the base with the greatest need as the first to receive any assets. This need is represented in the sort value. The computation is as follows:

$$2 + (NG / (AH + 1.0) / 100000.0)$$

where, NG = the number of aircraft currently grounded at this base due to this LRU assuming full cannibalization.
AH = the allowable holes for the LRU at the base

After the winning base has been chosen, the model tries to find the cheapest way for the depot to provide resupply to enable the base to fix it. The cheapest resupply option is to ship on-hand depot SRU stock to the bases so they can fix an AWP LRU, if they have any. Remember, the model computes the base AWP through the SRU holes and the full cannibalization assumption. It looks at the LRU with the fewest holes, and if there is on-hand depot stock (not Depot Maintenance Supply Center (DMSC) stock, though) for the missing SRUs it will choose this option. The next cheapest resupply option is to ship an on-hand depot serviceable LRU to the base. If neither of these options is possible, the model needs to consider using depot repair to create serviceables which can be sent to the base. In doing this, it computes the expected depot repair hours needed for three resupply alternatives:

1) Providing SRUs to the base so it can fix an AWP LRU
2) Fix an AWP LRU at the depot, then ship the LRU to the base
3) Induct and repair an LRU carcass at the depot, then ship the serviceable LRU to the base.

Of those that are possible from the three alternatives, the one with the lowest expected repair cost is chosen. Since the DRIVE system usually uses repair hours as the cost criterion, the expected repair hours computation will be described:

Alternative 1: The model again looks at the LRU with the fewest holes at the base. The repair hours are then accumulated for each of the needed SRUs for which there is no on-hand depot stock. The model will always use depot stock before asking for repair. If this sum exceeds the expected repair hours for inducting an LRU into depot repair, it is capped at that value minus 1.0. This prevents the model from asking for LRUs to be inducted into depot repair before shipping SRUs to the bases to fix an AWP item. If this alternative is not possible (i.e., there are no base AWP LRUs, or there aren't sufficient SRU depot assets), this alternative is ignored.

Alternative 2: The model looks at the current depot AWP LRUs and the SRUs that are needed to make each LRU serviceable. The LRU that can be fixed by using the fewest number of SRU repair hours is chosen. If there is depot stock or DMSC stock for an SRU, the SRU repair hours are zero. The repair hours for this alternative is the sum of the LRU repair hours and the needed SRU repair hours for this "cheapest" LRU. If this sum exceeds the expected repair hours for inducting an LRU into depot repair, it is capped at that value minus 0.5. This prevents the model from asking for LRUs to be inducted into depot repair before fixing current depot AWP LRUs. If it is not possible to resupply the base with an LRU in this manner (i.e., there are no depot AWP LRUs, or there aren't sufficient SRU depot assets), this alternative is ignored.

Alternative 3: This cost is a constant and is the LRU standard repair hours + expected cost for SRUs (i.e., sum across the SRUs of the replacement fraction times the SRU standard repair hours). If there are no LRU carcasses at the depot, this alternative is ignored. (Note that the LRU carcasses include both uninducted and non-AWP inducted assets, but the model still sees the action as an induction.)

Again, the resupply alternative with the smallest expected repair hours is chosen. Note that alternative 3 is the last option. All actions for the same alternative are assigned the same sort value. In other words, if the choice is to repair 2 SRU l's and ship these along with 1 SRU 2, for which there is depot stock, to a base, the same sort value will be assigned to all three actions. If the choice is to induct an LRU into depot repair, the model performs a separate optimization to provide SRU support for the LRU induction. It does this optimization after each LRU induction it suggests, regardless of the priority of the allocation. The LRU repair and all supporting SRU actions will be assigned the same sort value.

The SRU optimization is done as follows:

(a) The model assumes the SRU depot reparable generations (dep rep gens) from the LRU inductions will follow a binomial distribution where n = the number of DRIVE-suggested LRU inductions times the SRU QPA and p = the SRU replacement fraction. For each SRU, the probability of having enough SRUs to support the LRU inductions is the probability of having less than or equal to S SRU dep rep gens, where S equals the DMSC stock plus any DRIVE-suggested allocations to the DMSC. The probability of

having enough of all SRUs to support the LRU inductions is the product of the probabilities across all the SRUs. If this probability is less than a model parameter (currently set at 0.85), the model will try to send more SRUs to the DMSC with the following marginal analysis.

(b) For each SRU, a pseudo-sort value is computed. This is the relative increase in the overall probability from having 1 more of the SRU at the DMSC divided by the repair cost. The repair cost is 1.0 if there is depot stock (not including DMSC), and it equals the repair hours of the SRU if not. Even if there are no SRU carcasses at the depot, the model assumes that the carcass from the SRU dep rep gen can be repaired, so it won't restrict asking for the induction of an LRU due to lack of SRU carcasses. The SRU with the highest pseudo-sort value is chosen, then the new overall probability is compared with the model parameter. This process continues until the overall probability is at least as large as the model parameter. The model continues this process for the LRU family until all MICAPs have been satisfied, or until there are no more depot assets available to fix the MICAPs.

Due to DRIVE's objective function (see Appendix B), the base chosen to receive the next asset must improve overall aircraft availability more than the other locations. Logically, if aircraft availability will be raised, a "hole" should be filled by the asset; therefore, an open MICAP requisition should already exist from this location. However, it is possible for DRIVE to allocate assets to a base without a MICAP requisition over a base which has an active MICAP requisition. One case where this could happen would be when a base reports both a MICAP and a serviceable asset. DRIVE will apply the

serviceable asset at the base to the MICAP and eliminate both the MICAP and the serviceable asset. A non-MICAP may also be filled first due to indenture considerations. If a base has a MICAP against an LRU and the same LRU is DIFM while AWP for a SRU, DRIVE will attempt to send the SRU, if it's cheaper.

Phase 2 - Allocations to Bases in Poor Asset Position

These allocations are necessary because of a statistical condition that arises when using probability distributions and because of the nature of the DRIVE objective function. For the standard allocations, the marginal analysis requires that the sort values are always decreasing. The sort values are based on the relative increase in the base probability from each allocation, which is not necessarily a decreasing function (i.e., the relative increase does not necessarily always decrease as more allocations are given to the base). In fact, for bases with a poor asset position for an LRU family, the relative increase may temporarily increase as more allocations are made to a base. So, to make the marginal analysis for the standard allocations work properly, allocations must be made to force the base's probability function to the point where it is decreasing (the mathematical term is "concave").

The model examines the probability function for each base and determines whether or not it is concave. The bases that are not concave are the only ones that will receive allocations with this logic. Once again, the sort value is used as the representation of the need for each of the non-concave bases. The computation of the sort value for this class of allocations is as follows:

2 - BP

where, BP = the base probability

So, the effect here is to choose the base with the lowest probability as the next base to receive an allocation. The type of allocation is determined exactly as for MICAPs, where the objective is to make LRUs available at the bases in the cheapest manner for the depot. So, no SRUs will be shipped or repaired and shipped to a base unless they can be used to fix an AWP LRU (i.e., no SRU safety stock will be shipped to the bases during this class of allocations). The model continues this class of allocations until the probability function for all bases have been made concave, or until there are no more depot assets available for doing so.

Phase 3 - Standard Allocations

This is typically where most of the DRIVE allocations are made. At this point, there should be no more MICAPs at the bases and all the base probability functions should be concave. The logic for standard allocations is still based on marginal analysis, but the sort value has a different computation, which is:

$$(\ln(NP) - \ln(OP)) / RC$$

where, ln = the natural logarithm function
NP = the base probability if given the allocation
OP = the base probability without receiving anything else
RC = the "cost" of doing the allocation

The first step in computing the sort values is to determine, for each item in the LRU family, the cheapest way to create a serviceable part at the depot. This provides a sort value denominator for each item. The following table shows the costs:

Table 2-1.

Cost of Serviceable Parts

SOURCE	COST
Any item from depot stock	1.0
Inducting an SRU fixing a	SRU standard repair hours
depot AWP LRU	LRU standard repair hours + cost for the required SRUs (capped at the LRU induction cost minus 1.0)
Inducting an LRU	LRU standard repair hours + expected cost for SRUs (i.e., sum across the SRUs of the replacement fraction times the SRU standard repair hours)

If it is not possible to create a serviceable part by any of these means, the algorithm terminates. Once the costs have been determined, the model computes sort value numerators for each item in the LRU family and each base. The numerators are divided by the respective denominators to yield a matrix of sort values by item and base.

The next step is to determine the sort values for sending packages of SRUs to the bases. This is done by determining, for each base, the cheapest package needed to make an AWP serviceable (full cannibalization assumption). Sort values are then computed for each of these packages, where the repair cost for a package is the sum of the costs of providing each of the SRUs in the package. It is possible that the sort value for inducting an LRU and shipping it to a base will be higher than shipping it a package of SRUs. This

is not the desired choice, though. To prevent this, when this happens the sort value for the package is modified as follows:

$$(\ln(NIP) - \ln(OP)) / IC$$

where, ln = the natural logarithm function
NIP = the base probability after receiving an LRU from the depot
OP = the base probability without receiving anything else
IC = the LRU induction cost minus 1.01 (the AWP LRU cost was the LRU induction cost minus 1.0)

This has the effect of forcing packages of SRUs ahead of either inducting LRUs or fixing AWP LRUs.

Now, the model simply chooses the allocation that has the highest sort value. As in the MICAP and "concave" allocations, if the choice is to induct an LRU, the SRU optimization is done to ensure that the LRU repair will be able to be completed. If it is an allocation that involves more than one part (i.e., packages, fixing depot AWP, or inducting LRUs), each item in the allocation will be assigned the same sort value. The allocations continue for the LRU family until one of three conditions is met:

1. All available depot assets have been used up
2. A sort value limit has been reached (one of the model parameters is a minimum sort value)
3. The probability limit has been reached (another model parameter is a probability cut-off). This is the probability that all bases will meet their availability goals, or, in other words, the product of the base probabilities.

The result from each LRU family is a list sorted in decreasing order by sort value of recommended repair and distribution actions. This list can be used to produce a distribution list for each item in the family. Additionally, it can be merged with the lists of

other LRU families to produce repair lists which can be constrained by repair hours or dollars.

Section 5 - DRIVE Products

There are seven unclassified production products of DRIVE:

1) Computational Product Worksheet
2) Repair Quantities (items to be repaired)
3) Repair Quantities (identifies constraint limiting repair)
4) Maintenance Shop Priority List
5) Resource Utilization (hours)
6) Resource Hours (funding)
7) PC DRIVE Maintenance Shop Report

The mainframe reports are put out biweekly, but personal computer reports can be put out daily. The reports serve many purposes. They provide a prioritized list of items that should be repaired by NSN or Shop Identification (Repair Quantities Report or Maintenance Shop Priority List). The production reports provide a tactical tool for the maintenance scheduler. Quarterly reports provide a more strategic tool for negotiation purposes. The products prioritize NSN repair and distribution based on aircraft availability at least cost, and they facilitate dialog between users as they all are working with a consistent set of data.

Summary

DRIVE takes information such as aircraft availability goals, planned flying hours, and worldwide asset position and outputs repair sequences and distribution actions based on projected requirements, as determined by its algorithm. DRIVE is complicated and

relies on a large quantity data being accurate. Possibly the most important and potentially the most controversial aspect of DRIVE is its objective of maximizing the probability of locations meeting their assigned availability goals. This objective is a departure from the traditional priority system which has been utilized by the Air Force for decades, but has the potential to provide better results, in terms of weapon system availability. The results of previous research are discussed in the next chapter.

III. Literature Review

Chapter Overview

This chapter provides an overview of significant previous DRIVE research and information upon which this thesis is based. Overviews of two reports comparing DRIVE and UMMIPS done by AFMC and the Logistics Management Institute (LMI), as well as two Rand reports (R-3888-AF and R-4158-AF), are provided. The DRIVE model is discussed in detail in Chapter II of this thesis, but the UMMIPS model, which is also utilized in this research, will be briefly summarized here.

Uniform Material Movement and Issue Priority System (UMMIPS)

Department of Defense Directive (DoDD) 4410.6 prescribes UMMIPS; its implementation by the Air Force is covered in chapter 24 of Air Force Supply Manual (AFM) 67-1, Volume I, Part One. That document defines the policies, procedures, and guidelines for assigning a priority designator to requisitions for spare parts from the wholesale-to-retail level. The UMMIPS priority designator is a number from 1 to 15 that corresponds to one of five force/activity designators (FADs), and three urgency of need designators (UNDs). FAD 1 units, for example, are designated as most important in the opinion of the Joint Chiefs of Staff as approved by the Secretary of Defense. FAD 2 units are designated for deployment at the start of a conflict. FAD 3 units are designated for later deployment, but before 30 days. UND “A” can only be justified when the shortage renders a unit unable to perform its mission, UND “B” when the mission would be

impaired, and so on. The following table defines the requisition priority designator as a function of the five FADs and the three UNDs.

Table 3-1.

UMMIPS Requisition Priority Designators

FAD	UND		
	A	B	C
1	1	4	11
2	2	5	12
3	3	6	13
4	7	9	14
5	8	10	15

AFM 67-1 provides details on how units are assigned a FAD and lists definitions for UNDs A, B, and C. Those UNDs carry with them a standard for the order-and-ship time (OST) within which the item should be delivered to the requisitioner. Under UMMIPS, requisitions are filled in priority order. Within a priority, requisitions are filled by their preferential priority code (A-T), and within preferential priority codes they are filled on a first-come, first-served basis (by document number date) (Culosi and Eichorn, 1993).

AFMC UMMIPS/DRIVE Comparison

In their July 1992 XPS Technical Report #84-184-1, the AFMC team lead by Captain Frank Lindenbach compared the UMMIPS and DRIVE models in the distribution of assets to bases. With the expectation that DRIVE priorities will better reflect the needs of the operating forces than do the UMMIPS priorities, the team set out with the purpose

of comparing the performance of DRIVE and UMMIPS in distributing F-16 repaired assets to Air Force bases. The quantity of distributed assets selected was the planned depot quarterly repair quantity and was the same for each system. Actual asset posture and requisition data were used. Dyna-METRIC, which is the standard Air Force assessment model, was used as assessment model, as well as the Expected Not-Mission Capable - Supply (ENMCS) model (developed by Rand). Both models gave similar results.

Using aircraft availability as their measure of merit, they found DRIVE support was significantly better than UMMIPS. In allocating assets for the leading problem items on the F-16A/B, DRIVE would have supported an additional 45 fully mission capable aircraft (or 12.4% more than the 363 aircraft by UMMIPS) at 38 bases. DRIVE also provided more SRU assets to support LRU repair at the depots. The option of allocating some items according to DRIVE and some according to UMMIPS was also investigated. The best results were obtained when all items were allocated by DRIVE, but significant improvements were found for mixed allocation when key items (those in the poorest support posture) were allocated according to the DRIVE recommendations (Neumann and all, 1992).

LMI UMMIPS/DRIVE Comparison

In their March 1993 report "A Comparison of Two Systems for Distributing Spare Parts," Culosi and Eichorn of the LMI attempted to quantify the benefits of the Air Force's original concept of operations (CONOPS) for implementing DRIVE. In their

process of quantifying DRIVE's responsiveness, they discovered anomalies in the way UMMIPS was being implemented and in DRIVE's ability to support other claimants in addition to the units at Air Force bases. They set out to addresses the issues or current UMMIPS implementation, DRIVE's support to other than Air Force units, and DRIVE's ability to support Air Force units.

In their analysis of more than 22,000 requisitions for more than 1,300 NSN items used in F-15, F-16, and C-130 aircraft, they found that item managers routinely override the UMMIPS priorities for allocating spare parts. Without such item manager intervention, UMMIPS would have allocated more spares to foreign military sales customers and fewer to the depot overhaul program units at Air Force bases.

DRIVE was originally designed to improve the distribution of spares to units at Air Force bases. The authors believe the attempt to use DRIVE software to include the depot overhaul program, foreign military sales, and other services as "pseudo" bases and letting them compete with units at Air Force bases exceeds the original design concept and has not been satisfactory. They do not believe the Air Force has developed adequate criteria for balancing support across the four customers.

The authors concluded that the DRIVE concept for distributing spare parts giving highest priority to MICAP requisitions had the advantages of marginal improvements in aircraft availability, relative to the UMMIPS program, and it would do so without requiring item manager intervention, freeing them to do other aspects of their job. They also concluded that if DRIVE were constrained to set priorities for MICAP requisitions only and were then allowed to push all remaining assets without regard to requisitions, it

could reduce significantly the number of down aircraft relative to what would result from continuing with the UMMIPS program (Culosi and Eichorn, 1993).

Rand Reports on DRIVE (R-3888-AF and R-4158-AF)

The prototype of DRIVE was demonstrated at the Ogden Air Logistics Center in 1992. It was used to prioritize the repair and allocation of F-16 avionics LRUs and SRUs. The demonstration showed that such an approach was not only feasible, but also that it could be expected to yield substantial improvements in peacetime readiness and wartime sustainability without significant additional costs. Three cases were looked at in terms of percentages of F-16A/B aircraft not fully mission capable on day 30 of a nominal wartime scenario in which shortages of the components being prioritized by the DRIVE prototype induce nonavailability. In the first case, DRIVE is not used; the depot is left entirely to its own devices within the current depot repair planning system. In the second case, DRIVE is used only to allocate the serviceable assets emerging from repair. The third case reflects full compliance with DRIVE's recommended asset repairs and allocations. The result was roughly four additional squadrons of available aircraft on day 30 over the current system.

The conclusions from the Ogden demonstration were that Air Force Logistics Command (AFLC) and the Air Staff should proceed with resolution of the issues that are troublesome to full implementation of DRIVE, and develop a production version of the system. Since the Ogden demonstration, an adaptation of DRIVE called TRADES (Theater Repair and Distribution Executive System) was successfully demonstrated for use in managing repair and asset allocation at subdepot echelons of the system.

The authors believe that DRIVE development and demonstration is important in its implications for depot component repair management. They state that it is a concept that should be pursued by AFLC and the Air Staff to bring it to fruition (Abell and others, 1992; Miller and Abell, 1992).

Summary

This chapter provides background on DRIVE research and the models which are used in this research. It has been suggested by the authors of previous research that DRIVE could significantly reduce the number of down aircraft relative to what would result from utilization of the UMMIPS program, and that DRIVE should be pursued. This research attempts to examine DRIVE further by comparing 6 different levels of DRIVE implementation, while examining the effect on different priority locations. The methodology for this research is described in detail in the next chapter.

IV. Methodology

Chapter Overview

The reports done by the LMI and AFMC comparing DRIVE and UMMIPS provide the foundation for this research. Both of these studies, however, were done over three years ago and do not capture the current debates over the implementation of DRIVE. Many of the current debates revolve around the MICAP release sequences and that unconstrained DRIVE does not consider basic UMMIPS priorities when allocating assets.

This chapter describes the methodology used for the research, including the research objectives, data selection, research design, research questions, research hypotheses, significance of the research, research design implemented, and expected results.

Research Objectives

The goals of this thesis are three-fold:

1) To compare recently utilized or proposed asset allocation policies (mixes of the UMMIPS and DRIVE models) to test which best supports the LRU-using organizations and how much of a difference in projected AA, if any, exists between these policies.

2) To either support or refute previous research pertaining to comparisons of UMMIPS and DRIVE, which indicated that increased DRIVE implementation would be most beneficial.

3) To add the dimension of different FAD locations (including FAD one) to the research design in order to address any change in asset support which may occur to different priority (based on FAD) locations due to increased implementation of DRIVE.

The ten worst C-130H LRUs (as defined in the next section) will be compared over six decreasingly constrained DRIVE implementation levels to test whether increased implementation of DRIVE results in decreasing projected AA rates for high priority organizations. The results will be compared in terms of percent change in AA. MICAP requisitions will be focused on since they represent the items which drive AA most, and because allocation policies and release sequences to fill MICAPs have recently been the most debated aspects regarding the asset allocation function of DRIVE. Although DRIVE is a tool for prioritizing depot repair and distributing serviceable assets, only the distribution of assets is considered in this thesis.

Data Selection

In order to compare bases with different FADs, a weapon system had to be chosen which spanned a variety of bases with different FADs. The F-16 was initially considered, since it is a rich source of data relating to DRIVE implementation, but there are no FAD one F-16 bases. The C-130H was selected since C-130H models are utilized by FAD one bases as well as bases with a lower FAD. In order to represent an even comparison of UMMIPS and DRIVE, all weapon systems (other C-130 models) which utilize the selected LRUs at bases which utilize C-130Hs are included in this research. This was necessary since both filled and unfilled UMMIPS requisitions could be applied to any

weapon system at the selected C-130H installations. A limited number of LRUs were selected for this research because research levels two through four require a meticulous manual matching of allocations/requisitions. The addition of more LRUs would likely make the research more cumbersome with little added benefit.

For the purposes of this research, the ten worst LRUs are defined as the ten LRUs from the AFMC Get-Well Assessment Module (GWAM) (D087E) which are listed among the twenty critical items for the largest number of C-130H locations at the beginning of the quarter (1 Jan 96). Since these items are listed as critical to the greatest number of locations, they should have the greatest effect on AA across these locations. Critical items are items which are more intensively managed because they pose readiness and sustainability problems. The GWAM data base was used in order to get actual problem items, verses projected problem items. GWAM is a module of WSMIS which aids IMs, Equipment Specialists (ESs), System Program Managers (SPMs), and Major Commands (MAJCOMs) in identifying and analyzing items that pose readiness and sustainability problems. The purpose of GWAM is to support users both in performing more effective spares requirements forecasting for high-cost items and in developing and monitoring Get-well Plans for items in the Critical Item Program (AFLCM 400-381, 1991).

The C-130 LRU UMMIPS requisition data will represent an actual historical block of time consisting of 182 days (two quarters - Jan 96 through Jun 96). The historical data will be extracted from the D035A database in order to depict a recent scenario and representative transactions. The UMMIPS database used in this research consists of all requisitions (filled and unfilled) pertaining to the selected LRUs. The Desktop DRIVE

database will be built by Dynamics Research Corporation (DRC) and will also pertain only to the selected LRUs. The DRIVE database will contain all of the necessary information for model execution and proper asset allocations, including depot and base information pertaining to repair capabilities, demand data, interchangeable and substitute item groupings, Primary Assigned Aircraft (PAA), flying hours, AA goals, and asset posture.

The filled requisition data for the selected NSNs and locations of the period captured from the D035A will be used to determine how many of each particular NSN were actually distributed to the users over the period of time covered. These assets are the available quantities to be allocated by both models. All UMMIPS requisitions will be considered available at the beginning of the 182 day period, and all available assets for the period will be distributed on day 45.

Since DRIVE has been used in the distribution of assets for an extended period of time, the idea of using historical asset allocation data which was based on use of the DRIVE model was considered. Since DRIVE, however, has only been utilized for specific weapon systems and specific parts of those weapon systems, the historical data available would pertain only to a small pool of LRUs. Since this pool of LRUs is small, the expected AA based on these LRUs would not accurately represent the overall weapon system availability.

Research Design

In order to appropriately assess DRIVE's capabilities as an asset allocation tool for the Air Force, quantitative research involving actual Air Force conditions was needed. In

their evaluations of DRIVE, the 1992 AFMC and LMI studies quantitatively compared the existing UMMIPS system to the DRIVE model using actual requisition and asset position data. These studies were very useful in showing how the two systems would respond to the same situation. This research uses a similar approach of using UMMIPS as a baseline of comparison, while incorporating newly proposed levels of implementation and incorporating FAD one (high priority) bases into the pool of locations considered by the models.

This research will evaluate six implementation levels of DRIVE. The next level in the sequence below represents greater DRIVE utilization and fewer constraints on DRIVE allocations (see Figure 4-1 below).

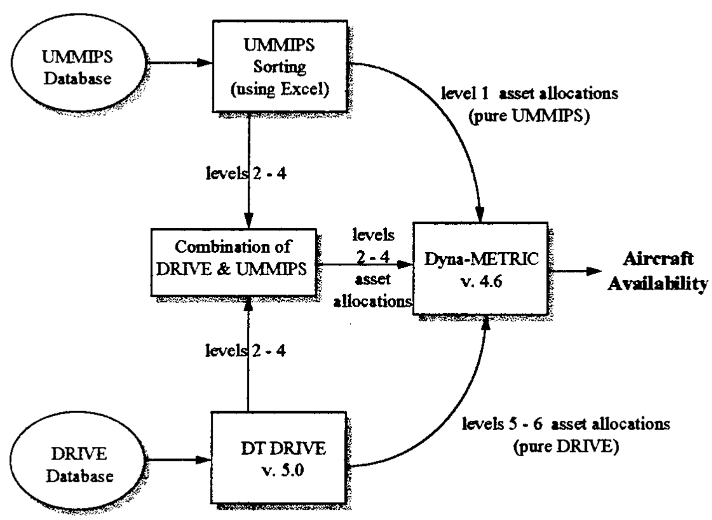

Figure 4-1. Methodology

The six levels are:

1) Pure UMMIPS allocation (DRIVE not used).

2) Latest HQ USAF/LGSP proposed release sequence:

a. Priority 01 requisitions

1. Priority 01 Joints-Chiefs of Staff (JCS) Project Code MICAP requisition

2. All priority 01 JCS Project Code Non-MICAP requisitions

3. All other priority 01 requisitions

b. MICAPs with JCS Project Codes

c. Overseas (OCONUS) MICAPs--no JCS Project Codes

d. Continental United States (CONUS) MICAPs--no JCS Project Codes

e. Mobility Readiness Spares Package (MRSP) replenishment with JCS Project Code

f. All other requisitions in DRIVE sequence

3) Initial DRIVE implementation. The release sequence is:

a. MICAP priority 01-03 JCS project code item requisitions

b. Non-JCS MICAP priority 01-03 requisitions

c. All other requisitions in DRIVE sequence

4) Previously proposed release sequence (not implemented):

a. MICAP priority 01 requisitions

b. All other requisitions in DRIVE sequence

5) Pure DRIVE allocation - must allocate MICAPs first

6) Pure DRIVE allocation - no requirement to honor MICAPs first

The release sequences in levels 2 through 4 represent "tie breakers" within established requisition priority groupings, as under UMMIPS. A common misconception is that, for example, all overseas MICAPs have priority over all CONUS MICAPs, as listed by sequence priorities c and d of level 2. In this case, only an overseas priority 02 (or higher) will have priority over a CONUS priority 02. All ties within a sequence priority are decided by traditional UMMIPS preferential priority codes, then by document number date, and so on. This is consistent with UMMIPS priorities.

The data will be run through Desktop DRIVE version 5.0 and/or (depending on the DRIVE implementation level) an Excel Spreadsheet which is used to sort requisitions in UMMIPS order to obtain the allocation data. For levels 2 through 4, which are a mix of the UMMIPS and DRIVE logic (using MICAP constrained DRIVE), UMMIPS and DRIVE allocations will both be accomplished. The allocations will then be appropriately combined, depending on the level of DRIVE implementation. The AA goals for each location will be set to the goals specified by the Air Staff for the period from which they were obtained, and will be held constant for the execution of all six DRIVE implementation levels for consistency of analysis. The default scenario settings within DRIVE will be utilized, which encompass a peacetime environment followed by 30 days of war. The AA goals used by DRIVE will therefore be 100 percent for all locations, since all Air Staff peacetime goals are 100 percent. The DRIVE Model run parameters will be set primarily in accordance with recommendations by the AFMC XPS Working Paper "DRIVE Model Parameters - Definitions and Recommended Settings" for quarter model runs (McCormick, 1994). The only changes are to set the planning horizon length

for 182 days (for two quarters), and change all Non-PAA availability goals to zero, since only Air Force Bases are being compared.

The resultant data from the research levels will consist of quantities of each NSN allocated to each SRAN, and will be input into Dyna-METRIC for analysis. Two data files which are used by DRIVE for model run parameters, named "scenario" and "part," will be reformatted, using an AFMC newly developed program, and used as the Dyna-METRIC version 4.6 assessment parameters file. This will ensure DRIVE and Dyna-METRIC parameters are identical. Each allocation file (from each research level) will be combined with the assessment parameters file (both in text format) to produce the final Dyna-METRIC input files for each research level. Dyna-METRIC will be set to assess each level after the 182 days of peacetime and then after an additional 30 days of war. Full cannibalization is assumed by both DRIVE and Dyna-METRIC, and all available assets will be allocated on day 45. Day 45 was chosen in order to make the assets available well before the observed days of 182 and 210 without loading all the bases' inventories on day one.

Dyna-METRIC is an analytical model which assesses the capability of logistics support to aircraft. It will assess the allocation data in terms of expected Non-Mission Capable Supply (NMCS) aircraft rates for each location and for the weapon system as a whole over all six levels. The model was developed from a series of Rand projects to improve aircraft readiness and supportability. It predicts the effect a particular stockage level has on the ability of the bases to meet their flying goals, in terms of aircraft availability. Specifically it forecasts how component failure, repair, and resupply

processes will affect component availability through the scenario, and it uses all components' availabilities to estimate how their replacement processes jointly affect aircraft availability for combat sorties (Isaacson and others, 1988).

Aircraft Availability (based only on NMCS aircraft) is used as the metric of comparison, since it is currently the most accepted metric for evaluating logistical support to an aircraft weapon system within the Air Force. Aircraft availability, for the purposes of this research, refers to the percentage of aircraft at a base that are missing none of the parts being considered. Each base has an availability goal specifying the percent of its aircraft that are to be complete (Miller and Abell, 1992). Aircraft availability is calculated by subtracting the result of the expected number of backorders (at a certain point in time, for a particular item) divided by the number of aircraft in the fleet from one. The results for each item are then multiplied to obtain the aircraft availability for the fleet. The basic equation is:

$$AA = \prod_{i=1}^{I} [1 - (EBO_i/NQ)]^{Qi}$$

where, AA = Aircraft availability
EBO = Expected number of backorders
N = Number of aircraft in the fleet
I = Number of items
Q = Quantity per aircraft

Aircraft availabilities for single locations are calculated using the number of expected backorders and the fleet size for that particular base, whereas overall availability is calculated using the sum of expected backorders and the sum of aircraft over all the research locations (Isaacson and others, 1988).

The research design used in this thesis consists of six levels of DRIVE implementation because there have been six implementation levels either proposed or already used. Research level one represents the UMMIPS model which has been utilized in the past. Level two represents the most recent Air Staff proposed asset release policy. Level three represents original and current DRIVE implementation. Level four represents a policy once proposed by the Air Staff, but subsequently replaced by the policy of level two. Level five represents sole use of DRIVE, while constrained to fill MICAP requisitions first. Level six represents use of the unconstrained DRIVE model. Although levels five and six have not been proposed for asset distribution policy, they are options to be considered. The C-130H weapon system was chosen due to its multiple models and roles which result in its use by both FAD one and FAD two organizations. The two quarter period was chosen because previous research had already looked at shorter periods for their comparisons, but it's meaningful to the depots to be able to look ahead further when determining where assets will be needed.

Research Questions

The following specific research questions were developed to support the comparison of the DRIVE implementation levels:

1. How does each DRIVE implementation level perform in terms of overall level of logistical support?

a) Which implementation level results in the highest overall projected aircraft availability?

b) What are the differences among the overall projected aircraft availability rates for each implementation level?

2. How does each DRIVE implementation level perform in terms of logistical support for each location (air force base)?

a) Which implementation level results in the highest projected aircraft availability for each location?

b) What are the differences among projected aircraft availability rates between each implementation level for each location?

c) What is the range between projected aircraft availability rates within each implementation level?

3. How does each DRIVE implementation level perform in terms of logistical support for locations (bases) with different FADs?

a) Which implementation level results in the highest projected aircraft availability for locations with the same FAD?

b) What are the differences among projected aircraft availability rates between each implementation level for locations with the same FAD?

c) What are the differences among projected aircraft availability rates between locations with a different FAD within each implementation level?

Research Hypotheses

The following non-statistically based hypotheses were developed for this research:

1) In order to answer the first research question, the null hypothesis to be tested is:

Projected overall aircraft availability (A) of level x is equal to the projected overall aircraft availability of level x + 1.

H_o: $A_x = A_{x+1}$

H_a: $A_x \neq A_{x+1}$

where A_x equals the projected overall aircraft availability of implementation level x, and A_{x+1} equals the projected overall aircraft availability of the next increased DRIVE utilization level.

2) In order to answer the second research question, the null hypothesis to be tested is: The minimum projected aircraft availability of level "B" is equal to the maximum projected aircraft availability of level "B".

H_o: $B_{min} = B_{max}$

H_a: $B_{min} \neq B_{max}$

where B_{min} equals the minimum projected aircraft availability of all research locations for implementation level B, and B_{max} equals the maximum projected aircraft availability of all research locations for implementation level B.

3) In order to answer the third research question, the null hypotheses to be tested are:

a) Average projected aircraft availability of level x for Bases with FAD "F" is equal to the projected aircraft availability of level x + 1 for Bases with FAD "F".

H_o: $F_x = F_{x+1}$

H_a: $F_x \neq F_{x+1}$

where F_x equals the average projected aircraft availability of implementation level x for bases with FAD F, and F_{x+1} equals the average projected aircraft availability of the next increased DRIVE utilization level at bases with FAD F.

b) Average projected aircraft availability of level x for Bases with FAD "F" is equal to the average projected aircraft availability of level x for Bases with FAD "G".

H_o: $F_x = G_x$

H_a: $F_x \neq G_x$

where F_x equals the average projected aircraft availability of implementation level x at bases with FAD B, and G_x equals the average projected aircraft availability of the same implementation level at bases with FAD G.

Average projected aircraft availability for each FAD will be calculated using each location's projected AA, weighted by the location's peacetime PAA.

Significance of Research

The reluctance on the part of many organizations to accept DRIVE seems to be motivated primarily by a perceived loss of advantage, due to the fact that DRIVE, in its unconstrained form, doesn't consider location priority (FAD). An example of this is Air Force Special Operation's request that they not lose their FAD one priority consideration. This research is meant to be an extension of previous research by showing the effect that increased or full DRIVE implementation would be expected to have on priority organizations, using existing AA goals. The results are meant to aid United States Air

Force policy makers in choosing the best asset distribution model for the future of logistics support.

Research Design Implementation

The research will be accomplished in the following four phases:

Phase 1 - The ten worst C-130H LRUs will be determined using the GWAM data base, as stated above.

Phase 2 - Requisition data for the LRUs selected in phase one will be extracted from the D035A database for the observed two quarters. This data represents the UMMIPS database. A Jan 96 DRIVE database for the LRUs selected in phase one will be obtained from Dynamics Research Corporation (DRC) representing worldwide asset position, repair information, demand data, and all other necessary information for DRIVE Model calculations. These two data bases will be used to allocate assets for the 6 different research levels. The requisitions database will be sorted per UMMIPS logic for level one, Desktop DRIVE will be run for levels five and six, and the results of levels one and five will be combined for levels two, three, and four. The combination of UMMIPS and DRIVE for levels two through four will be reconciled and combined (as stated in the Research Design above) in such a way as to avoid double allocations of items upon which both models agree (i.e. if a SRAN has already been allocated 2 assets through UMMIPS logic, the first two allocations of the same NSN to the same SRAN will be deleted from the DRIVE allocations list before the two model allocations are combined). The result of

this phase will be a list of quantities of each NSN to be allocated to each SRAN for each level.

Phase 3 - The asset allocation recommendations for all six levels, determined in phase two, will be combined with the Dyna-METRIC input file (the reformatted Desktop DRIVE scenario and part files) and run through Dyna-METRIC version 4.6 in forward mode (assessment mode). The Dyna-METRIC output will consist of expected Fully Mission Capable (FMC) rates (based on NMCS rates) for each SRAN and all SRANs as a whole, resultant from the six level asset allocations. Dyna-METRIC reports will be generated on days 180 and 210 (actually days 182 and 210 due to Dyna-METRIC Model time-scaling) representing results after 180 days of peacetime (report - day 182) and 180 days of peacetime followed by 30 days of war for units with a wartime mission (report - day 210). Results from these two different points in time will be looked at since DRIVE allocates assets based on the assumption that there will be a 30 day war at the end of the planning horizon, whereas UMMIPS does not. All assets to be distributed to the SRANs will be made available on day 45, and allocations are based on full cannibalization.

Phase 4 - The overall weapon system AA (FMC) rates, individual base AA rates, and average AA rates based on FAD will be compared in order to ascertain any differences across the tested DRIVE implementation levels.

Since an analytical assessment model is being utilized and the sample of LRUs is non-random, statistical comparisons based on random samples are inappropriate. Resultant AA rates will be compared based on percentage difference. These comparisons will help guide future research in determining the significance of these differences. This

assessment method will also be used in order to be consistent and comparable with previous research, which used the same method of comparison. This analysis is also meant as a baseline for possible future research involving sensitivity analysis, changes in parameters, or altered assumptions.

Expected Results

Greater utilization and less constrained use of DRIVE would be expected to result in higher overall weapon system availability (across all bases), but less AA advantage over non-priority locations by the higher priority locations (FAD one bases). This is expected due to DRIVE's objective of maximizing AA over a group of locations as a whole, and because the current DRIVE AA goals give no preferential treatment to bases with a higher FAD when DRIVE is run unconstrained. Whether priority locations will actually have reduced expected AA rates with greater DRIVE utilization is unknown, and is the reason for this research.

Summary

The ten worst C-130H LRUs will be compared over six decreasingly constrained DRIVE implementation levels to see the effect, in terms of AA rates, of increased implementation of DRIVE on 1) all C-130H bases as a whole, 2) each individual C-130H base, and 3) groups of bases with the same FAD. The results will be compared in terms of percent change in AA. All expected AA rates generated in this research are based on the

developed research scenario that the selected ten LRUs solely drive the weapon system expected backorders and AA. This research builds on previous research results, and is meant to serve as a baseline for future research and as an aid to decision makers in planning the future of asset allocation policy. Chapter V will cover an analysis of the results of the research levels explained in this chapter, based on the research questions.

V. Results and Analysis

Chapter Overview

This chapter presents the results and analysis of the six different research levels used in this thesis. The chapter is divided into two sections. The first section discusses the research findings at each phase of the research methodology, and the second section looks at the research results in terms of the research questions and hypotheses.

Research Findings

Phase 1. The GWAM listing of top twenty critical items for C-130Hs at the end of December 1995 was reviewed for candidate LRUs for this study. LRUs were avoided which had low NRTS rates (therefore few requisitions) or were utilized by organizations of a single FAD. Ten LRUs were chosen which were critical items (as determined by GWAM) to the largest number of SRANs, to include locations of different FADs. After receiving requisition data on the selected LRUs, it became necessary to eliminate four. Two of the LRUs' interchangeable and substitute groupings had been changed during the two quarters being used; therefore, adequate information was not available. One LRU was utilized on weapon systems other than the C-130. The fourth LRU had no assets allocated to the observed locations during the two quarters. The six chosen LRU NSNs were:

1610013184870	1660000620301	1660003434692
6615010657226	4810006122696HS	4810010390459TP

Phase 2. A total of 33 different United States Air Force C-130H SRANs, consisting of Active Duty, Air National Guard, and Air Force Reserve organizations, utilize the chosen six stock numbers, and were examined in this research (see Appendix C). The available assets, represented by total assets distributed to all 33 SRANs between 1 Jan 96 and 31 Jun 96, are as follows:

Table 5-1.

Available Assets

NSN	Quantity Available
1610013184870	89
1660000620301	135
1660003434692	68
6615010657226	174
4810006122696HS	32
4810010390459TP	8

These quantities of assets were distributed using the six different research levels (see Appendix D). The available quantities were constraining for both the UMMIPS and DRIVE allocations (i.e. there were more requisitions/allocations than available assets).

Phase 3. Dyna-METRIC version 4.6 (analytical) was run five times (once for each of the five different levels) using the Dyna-METRIC input file combined separately with the five different asset allocation files. Only five runs were necessary, versus six, because levels four and five were identical, since there were no priority one MICAP requisitions. Expected aircraft availability rates for each SRAN and all SRANs as a whole, for each research level, after 180 days of peacetime and for 180 days of peacetime followed by 30

days of war were obtained. The results are based on full cannibalization and repair capability throughout the time period (see Table 5-2 below).

Table 5-2.

Expected Aircraft Availability Rates

		Day	182					Day	210			
		L1	L2	L3	L4&5	L6		L1	L2	L3	L4&5	L6
Base		%	%	%	%	%		%	%	%	%	%
SRAN		FMC	FMC	FMC	FMC	FMC		FMC	FMC	FMC	FMC	FMC
----		---	---	---	---	---		---	---	---	---	---
2500		78	91	95	95	95		70	83	87	87	87
2823		96	96	95	95	95		90	90	89	89	89
3010		95	95	97	97	97		87	83	89	89	89
3300		89	86	89	89	89		83	79	83	83	83
4417		100	100	100	100	100		100	100	99	99	99
4460		90	96	97	97	97		81	90	92	92	92
4469		51	74	82	82	82		100	100	100	100	100
4661		91	93	97	97	97		76	81	87	87	87
4810		100	100	100	100	100		100	100	100	100	100
4877		87	91	95	95	95		81	86	90	90	90
5000		92	92	92	92	92		85	85	86	86	86
5209		85	93	94	94	94		77	86	88	88	88
5518		100	100	99	99	99		100	100	98	98	98
6081		88	89	94	94	94		82	82	88	88	88
6102		96	96	97	96	96		91	89	92	91	91
6161		88	91	96	92	92		75	80	88	83	83
6252		87	85	94	94	94		80	79	88	88	88
6323		88	87	96	95	95		85	83	91	90	89
6331		80	90	91	91	91		71	84	86	86	85
6353		74	84	94	94	94		65	78	88	88	88
6421		88	91	91	91	91		80	84	85	85	85
6431		82	86	94	94	94		73	80	88	88	88
6481		95	89	94	94	94		90	83	88	88	88
6501		85	88	95	95	95		78	82	89	89	89
6520		86	89	91	91	91		79	83	86	86	86
6530		90	82	84	83	83		82	71	76	73	73
6562		88	84	94	94	94		82	79	87	87	88
6605		84	84	89	89	89		78	77	83	83	83
6618		82	90	92	92	92		73	82	85	85	85
6656		87	89	92	95	95		68	74	78	85	85
6670		93	92	94	94	94		87	84	87	87	87
6703		87	84	89	89	89		80	77	83	83	83
6712		82	86	90	90	90		75	81	85	85	85

Table 5-2 (continued)

Total		89	92	95	95	95		83	86	90	90	90

Phase 4. An analysis of the results obtained in Phase three is contained in the next section of this chapter.

Research Questions and Results

Research Question 1. How does each DRIVE implementation level perform in terms of overall level of logistical support?

Table 5-3.

Overall Expected Aircraft Availability Rates

	Day	182					Day	210			
	L1	L2	L3	L4&5	L6		L1	L2	L3	L4&5	L6
	%	%	%	%	%		%	%	%	%	%
	FMC	FMC	FMC	FMC	FMC		FMC	FMC	FMC	FMC	FMC
	---	---	---	---	---		---	---	---	---	---
Total	89	92	95	95	95		83	86	90	90	90
change	n/a	3	3	0	0		n/a	3	4	0	0

a) Which implementation level results in the highest overall projected aircraft availability? The overall results from days 182 and 210 were consistent in that levels three through six yielded equally the highest results for both days. Equal expected weapon system availabilities of 95 percent and 90 percent for days 182 and 210, respectively, were obtained for research levels three through six (see Table 5-3 above).

b) What are the differences among the overall projected aircraft availability rates for each implementation level? The null hypothesis to be tested is: Projected overall

aircraft availability (A) of level x is equal to the projected overall aircraft availability of level x + 1.

H_o: $A_x = A_{x+1}$

H_a: $A_x \neq A_{x+1}$

where A_x equals the projected overall aircraft availability of implementation level x, and A_{x+1} equals the projected overall aircraft availability of the next increased DRIVE utilization level.

As shown in Table 5-3 above, there is a total six percent and seven percent positive change in expected availability between levels one and six for days 182 and 210, respectively. There is no difference in expected availability rates across levels three through six for both days.

Research Question 2. How does each DRIVE implementation level perform in terms of logistical support for each location (air force base)?

a) Which implementation level results in the highest projected aircraft availability for each location? The number of occurrences of each level (including ties) resulting in the highest projected aircraft availability can be seen in Table 5-4 below. See Appendix E for a complete list of data.

Table 5-4.

Summary of Individual Locations' Highest Levels

Best Level	# SRANS Day 182	# SRANS Day 210
L1	8	9
L2	6	5
L3	28	26
L4	26	24

Table 5-4 (continued)

L5	26	24
L6	26	24

(Note: all ties included, therefore column sums exceed 33)

Levels three through six had the greatest availability for the greatest number of locations, by far.

b) <u>What are the differences among projected aircraft availability rates between each implementation level for each location</u>? The null hypothesis to be tested is: The minimum projected aircraft availability of level "B" is equal to the maximum projected aircraft availability of level "B".

H_o: $B_{min} = B_{max}$

H_a: $B_{min} \neq B_{max}$

where B_{min} equals the minimum projected aircraft availability of all research locations for implementation level B, and B_{max} equals the maximum projected aircraft availability of all research locations for implementation level B.

The ranges of expected aircraft availability rates across the six experimental levels vary from no change (for three locations on day 182 and two locations on day 210) to as much as 31 percent for one location on day 182 (see Table 5-5 and Figure 5-1 below). On day 182, 75 percent of the SRANs had less than a 10 percent difference between all research levels, and on day 210, 60 percent of the SRANs had less than a ten percent difference between all research levels.

Table 5-5.

Ranges of Expected Availability Rates For Each Location

Day	182		Day	210
%			%	
FMC	#		FMC	#
range	SRANs		range	SRANs
----	----		----	----
0	3		0	2
1	3		1	3
2	2		2	1
3	2		3	2
5	3		4	1
6	3		5	1
7	1		6	4
8	5		7	2
9	3		8	1
10	3		9	3
11	1		10	1
12	1		11	5
17	1		12	1
20	1		13	1
31	1		15	2
			17	2
			23	1

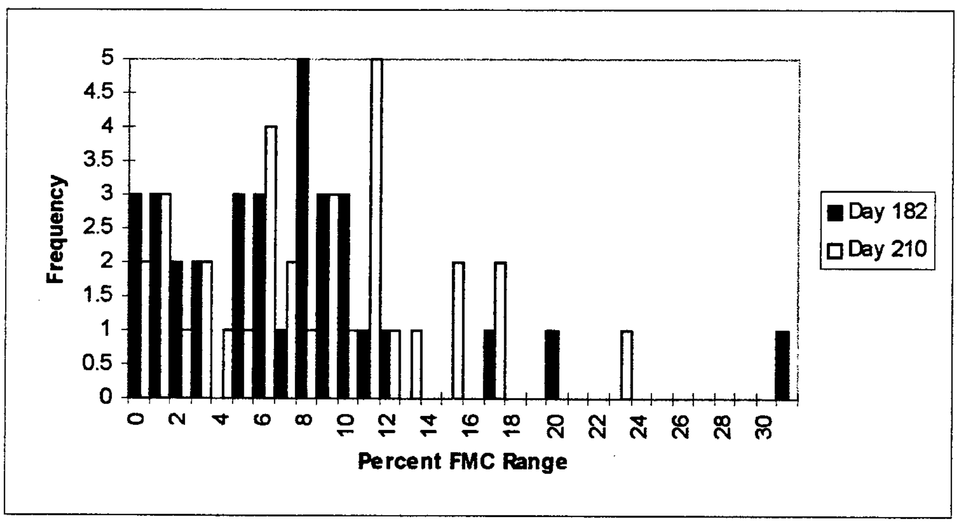

Figure 5-1. Ranges of Expected Availability Rates

The majority of the SRANs included in the research experienced their greatest change in expected aircraft availability at either level two or level three (73 and 85 percent of the SRANs, respectively, for days 182 and 210) from the next lower level of DRIVE implementation (see Table 5-6 below). On both days 182 and 210 the greatest number of locations (SRANs) saw the greatest change in availability solely from level two (the first and lowest level of DRIVE implementation) to level three (current operating policy). For the locations where level three showed the largest change (including ties), there were 18 positive changes (averaging 5.33) and 2 negative changes (averaging -1.00) for day 182, and 15 positive changes (averaging 5.93) and 3 negative changes (averaging -1.33) for day 210. See Appendix E for a complete list of data.

Table 5-6.

Research Level of Greatest Change

Day 182			Day 210	
	level of			level of
#	greatest		#	greatest
SRANs	change		SRANs	change
----	----		----	----
15	L3		16	L3
9	L2		12	L2
4	L2, L3		2	no change
3	no change		2	L2, L3
2	L3 - L5		1	L4, L5

c) <u>What is the range between projected aircraft availability rates within each implementation level</u>? On day 182, the largest range of availability rates was 49 for level one and the smallest was 18 for levels three through six. On day 210, the largest range of

availability rates was 35 for level one and the smallest was 24 for level three (see Table 5-7 and Figure 5-2 below).

Table 5-7.

Ranges of Expected Availability Within Each Research Level

Day	L1	L2	L3	L4&5	L6		Day	L1	L2	L3	L4&5	L6
182	%	%	%	%	%		210	%	%	%	%	%
	FMC	FMC	FMC	FMC	FMC			FMC	FMC	FMC	FMC	FMC
	---	---	---	---	---			---	---	---	---	---
min	51	74	82	82	82		min	65	71	76	73	73
max	100	100	100	100	100		max	100	100	100	100	100
range	49	26	18	18	18		range	35	29	24	27	27

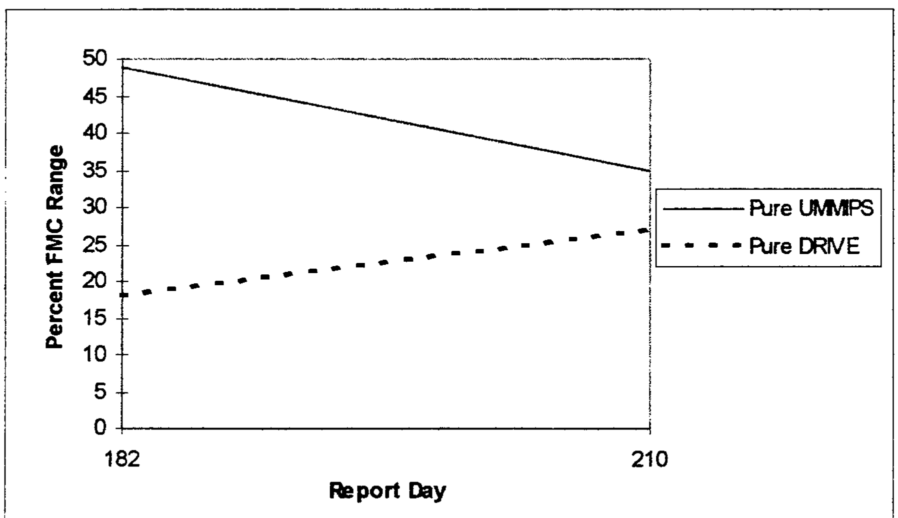

Figure 5-2. Levels One and Six Ranges of Expected Availabilities

Research Question 3. How does each DRIVE implementation level perform in terms of logistical support for locations (bases) with different FADs?

Average projected aircraft availability for each FAD was calculated using each location's projected AA, weighted by the location's peacetime PAA.

Table 5-8.

Comparison of Different FAD Locations

	Day	182					Day	210			
	L1	L2	L3	L4&5	L6		L1	L2	L3	L4&5	L6
	%	%	%	%	%		%	%	%	%	%
	FMC	FMC	FMC	FMC	FMC		FMC	FMC	FMC	FMC	FMC
	---	---	---	---	---		---	---	---	---	---
FAD 1	99.17	99.17	98.86	98.86	98.86		97.92	97.92	96.82	96.82	96.82
change	n/a	0.00	-0.31	0.00	0.00		n/a	0.00	-1.10	0.00	0.00
FAD 2	87.42	91.14	94.40	94.36	94.36		79.26	83.96	88.13	88.22	88.19
change	n/a	3.72	3.27	-0.04	0.00		n/a	4.71	4.17	0.08	-0.03
FAD 1-2											
difference	11.75	8.03	4.45	4.50	4.50		18.67	13.96	8.69	8.60	8.63

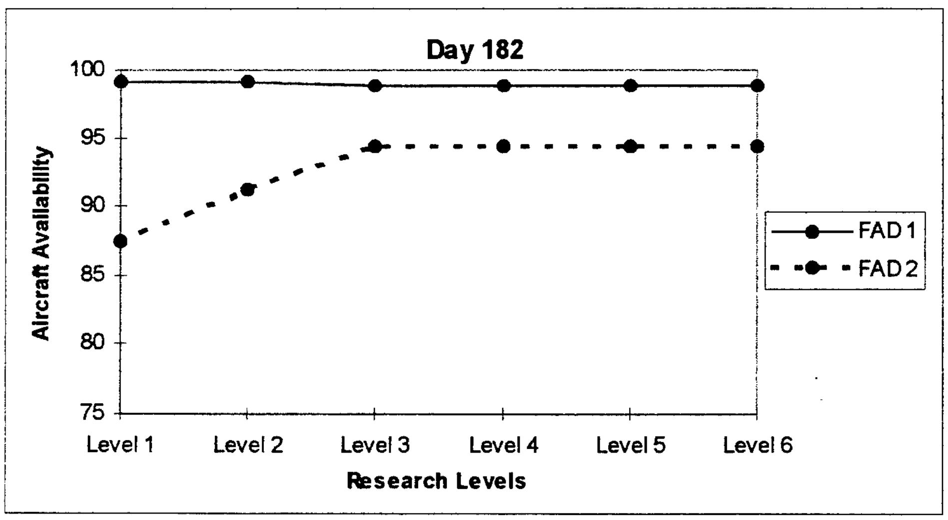

Figure 5-3. Day 182 Aircraft Availabilities by FAD

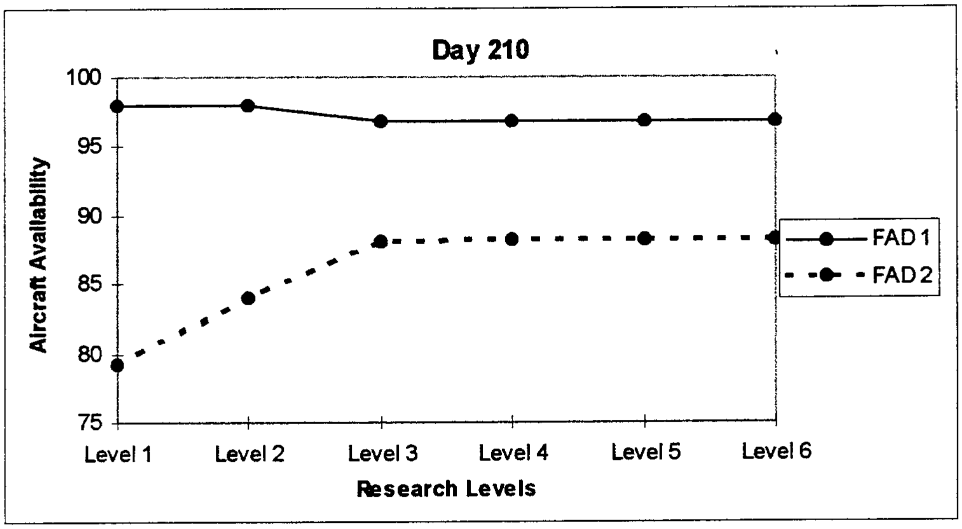

Figure 5-4. Day 210 Aircraft Availabilities by FAD

a) Which implementation level results in the highest projected aircraft availability for locations with the same FAD? Levels one and two yielded the highest availability rates for the three FAD one locations for both days. Levels three through five yielded the highest availability for the 30 FAD two locations for days 182 and 210, respectively (see Table 5-8 and Figures 5-3 and 5-4 above).

b) What are the differences among projected aircraft availability rates between each implementation level for locations with the same FAD? The informal null hypothesis to be tested is: Average projected aircraft availability of level x for Bases with FAD "F" is equal to the projected aircraft availability of level x + 1 for Bases with FAD "F".

H_o: $F_x = F_{x+1}$

H_a: $F_x \neq F_{x+1}$

where F_x equals the average projected aircraft availability of implementation level x for bases with FAD F, and F_{x+1} equals the average projected aircraft availability of the next increased DRIVE utilization level at bases with FAD F.

There was no change in the results across the FAD one bases, except for level three. For all implementation levels above level three, FAD one bases had expected availabilities 0.31 percent and 1.10 percent lower than the expected availabilities for levels one and two, on days 182 and 210 respectively. The FAD two locations had their greatest increase in availability at level two (3.72 and 4.71 percent for days 182 and 210 respectively) with another comparable increase at level three (3.27 and 4.17 for days 182 and 210 respectively) (see Table 5-8 above).

c) <u>What are the differences among projected aircraft availability rates between locations with a different FAD within each implementation level</u>? The informal null hypothesis to be tested is: Average projected aircraft availability of level x for Bases with FAD "F" is equal to the average projected aircraft availability of level x for Bases with FAD "G".

H_o: $F_x = G_x$

H_a: $F_x \neq G_x$

where F_x equals the average projected aircraft availability of implementation level x at bases with FAD B, and G_x equals the average projected aircraft availability of the same implementation level at bases with FAD G.

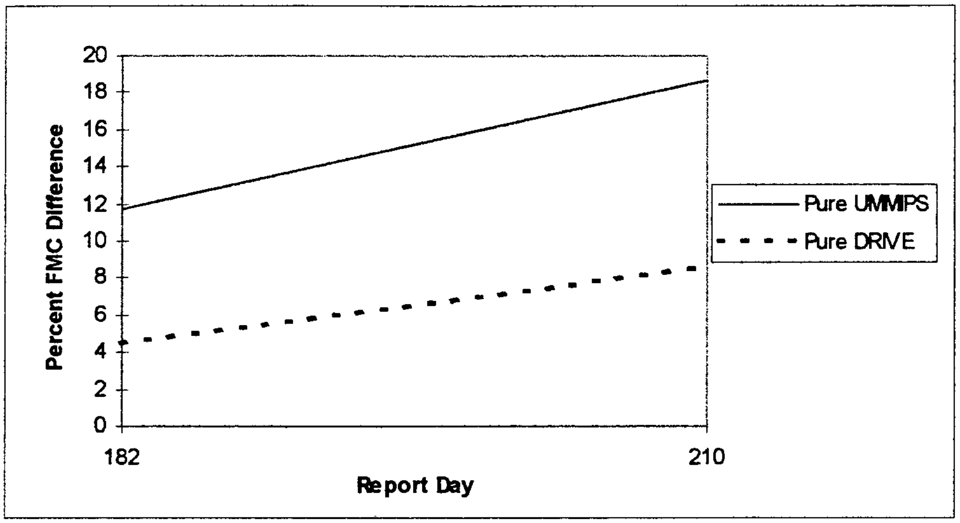

Figure 5-5. Differences Between FADs One and Two Locations for Levels One and Six

The greatest difference between the different FAD locations for the same research level was in level one for both days (11.75 and 18.67 for days 182 and 210 respectively). The differences in availability between the different FAD locations decreased steadily from level one to level three on both days with levels three through six showing differences which varied by only 0.05 for day 182 and 0.09 for day 210 (see Table 5-8 and Figure 5-5 above).

Summary of Results

Results from the six different research levels relating to the research questions and hypotheses were presented in this chapter. No statistical tests could be used in this study to show statistical significance, due to the assumption violations for both parametric and non-parametric techniques. Results were analyzed using comparisons based on differences and averages, which adequately convey the results for the purposes of this study. Tables

were used to concisely show the resulting expected aircraft availability rates as they apply to the research questions. Conclusions from the research, implications for the Air Force, and future research recommendations, based on the analyses accomplished in this chapter, will be discussed in Chapter VI, which follows.

VI. Conclusions and Recommendations

Chapter Overview

Chapter V provided data from which conclusions can now be based. This chapter utilizes the analysis of the data from chapter V and incorporates it into conclusions about the proper level of DRIVE implementation, based upon each research question within the scope of the research used in this thesis. The conclusions are also interpreted as to their implications for the United States Air Force, and suggestions as to future research avenues are made.

Interpretations/Conclusions

Conclusions based on the research questions and the data analysis from Chapter V will be addressed below.

1. How does each DRIVE implementation level perform in terms of overall level of logistical support?

a) Which implementation level results in the highest overall projected aircraft availability? The results provide evidence that levels three through six provide equally the highest overall projected aircraft availability. Level three represents the current level of DRIVE implementation, with MICAP priority 01-03 JCS project code item requisitions and Non-JCS MICAP priority 01-03 requisitions being filled (using UMMIPS logic) before DRIVE logic is utilized. Level four represents MICAP priority 01 requisitions being filled before DRIVE logic is utilized. Level five represents the use of only DRIVE

logic, constrained to fill MICAPs first. Level six represents the sole use of DRIVE logic (unconstrained). There were no differences among the research results for levels three through six.

b) What are the differences among the overall projected aircraft availability rates for each implementation level? The results provide evidence that utilization of UMMIPS logic alone (level one) results in lower overall expected aircraft availability rates for both 182 days of peacetime and 182 days of peacetime followed by 30 days of war, than any level with DRIVE being used. A three percent increase in aircraft availability was observed on both days 182 and 210 for level two when DRIVE is utilized only after all priority one, MICAP, and JCS coded MRSP replenishment requisitions were first filled. A three percent increase equates to 14 additional aircraft being fully mission capable. An additional increase of three and four percent (for days 182 and 210 respectively) resulted for levels three through six over level two. The increased availability for levels three through six represents an additional 14 and 19 fully mission capable aircraft (for days 182 and 210 respectively) compared to level two.

2. How does each DRIVE implementation level perform in terms of logistical support for each location (air force base)?

a) Which implementation level results in the highest projected aircraft availability for each location? This research provides evidence that the majority of the locations (61 percent on day 182 and 55 percent on 210) would have higher aircraft availability utilizing any of levels three through six. An additional 13 locations on day 182 and 16 locations on day 210 had at least one of levels three through six as their highest level. Level one (pure

UMMIPS) resulted in the highest rates for eight locations on day 182 and nine locations on day 210 (including ties).

b) What are the differences among projected aircraft availability rates between each implementation level for each location? The research results provide evidence to indicate level three (current operating policy) produces the greatest increase in aircraft availability (over the next lower DRIVE implementation level) for the greatest number of bases (15 on day 182 and 16 on day 210). Research level two (the most limited utilization of DRIVE) produces the greatest increase in availability for the next largest number of locations (9 on day 182 and 12 on day 210). The range of rates for each location varied from zero (no change across the levels) to as much as 31 for one location on day 182.

c) What is the range between projected aircraft availability rates within each implementation level? The research results provide evidence to indicate that utilization of DRIVE results in a smaller range of availability rates across all bases. Levels three through six had equally the lowest ranges of availability rates on day 182 (a range of 18), and level three had the lowest range of values on day 210 (a range of 24) with levels two, four, five, and six also having smaller ranges than level one.

3. How does each DRIVE implementation level perform in terms of logistical support for locations (bases) with different FADs?

a) Which implementation level results in the highest projected aircraft availability for locations with the same FAD? Results of this research provide evidence that FAD one locations generate slightly higher aircraft availability rates using UMMIPS logic (level one) solely, and FAD two locations generate higher aircraft availability rates using DRIVE

logic of levels three through six. For the FAD two locations, level one resulted in the lowest rates, level two resulted in higher rates, and levels three through six were the highest with less than a 0.04 difference among these four levels. There was little difference between the highest and lowest FAD one results.

b) What are the differences among projected aircraft availability rates between each implementation level for locations with the same FAD? Research results indicate that FAD one bases are affected little by the different levels of DRIVE implementation. This result, however, could have been affected by larger asset quantities at these bases at the beginning of the research period. The overall range of rates for FAD one locations was only 0.49 for day 182 and 1.10 for day 210 across all levels, showing evidence that there is little difference between any of the implementation levels. The overall range of rates for FAD two locations was 6.98 for day 182 and 8.96 for day 210.

c) What are the differences among projected aircraft availability rates between locations with a different FAD within each implementation level? As expected, the results show evidence that there is a greater difference in aircraft availability rates between the results of FAD one and FAD two bases when UMMIPS logic is used versus DRIVE. For both days 182 and 210, level one showed the greatest difference between the different FAD bases (11.75 and 18.67 respectively). The difference between the two sets of priority locations reduced to 8.03 for day 182 and 13.96 for day 210 using level two. Differences for levels three through six were lower still, with little variation.

Implications for the Air Force

The conclusions discussed above have several implications for inventory and MICAP policy within the Air Force. First, since no improvement was shown for asset allocation policies utilizing DRIVE greater than current implementation, the results offer no support for any emphasis on greater DRIVE implementation. There is, however, another significant implication associated with no substantial change in results through the use of pure DRIVE. This research gives evidence that DRIVE can forecast asset requirements as far ahead as 210 days (including a 30 day war scenario) and yield results better than UMMIPS alone or the same as current asset allocation policy.

Second, the latest Air Staff proposed asset release sequence was represented by research level two, but this research shows evidence that the greatest improvement in aircraft availability was experienced with level three (current operations) implementation. This means that aircraft availability rates could actually drop if the new policy is put into effect.

A third implication is that FAD one bases are not appreciably affected by higher levels of DRIVE implementation. Although FAD one locations did experience a slight drop in availability rates, goals within DRIVE can be set higher for higher priority organizations to ensure higher aircraft availability than other locations. The research showed evidence that FAD two locations benefited from DRIVE implementation with higher availabilities, and all locations as a whole benefited from DRIVE implementation.

Suggestions for Further Research

This thesis covered only one research avenue of many. Due to the large variety of parts the Air Force uses, the many parameters which can be changed in running the DRIVE model, and the many scenarios which can be observed, there are countless ways of researching DRIVE implementation results. Both narrowly or broadly scoped studies could be useful. Based on insight gained from doing this research, the following avenues of research pertaining to DRIVE implementation are particularly recommended.

1) Similar research to this thesis could be done with all bases equal at the beginning of the observation period. All bases would either have no assets in stock or in transit, or all bases would start with enough assets to maintain the same availability as the other bases for the same period of time. This would reduce the potential for initialization bias due to previous asset positions.

2) Similar research to this thesis could be done using different levels of higher base availability goals for higher FAD locations to determine the effects on all locations.

3) A comparison of different utilization levels and varied parameter settings within DRIVE in order to see how DRIVE reacts to various situations using a tailored, theoretical database (not real-world data) would be insightful. This comparison would reduce the possibility of errors due to inaccurate data, while examining very specific model characteristics.

4) Studies of larger or similar scope to this research would be useful for comparison if different weapon systems, periods, and/or database sizes were used to assess the generalizability of these results.

5) Similar research to this thesis involving sensitivity analysis and different parameter settings, such as using different MICAP options (different sort values), different planning horizons, different peacetime/wartime scenarios, or any of the other model settings would be beneficial. This information would add to the understanding of the model and its options.

6) Research with the added dimension of distributing allocated assets at different times or in various stages throughout the planning horizon might add more "realism" to the results of the study by permitting analyses over time.

7) Studies involving the sensitivity of DRIVE to inaccurate data would provide important information on the effects of poor data on DRIVE's ability to properly allocate assets or improve aircraft availability.

8) Another possible avenue is to investigate the range interaction effect between UMMIPS and DRIVE allocations results, which was shown in Chapter V.

Summary of Research

This research addressed the problem of proper implementation of the DRIVE model into inventory distribution policy for the Air Force. The first chapter served as an introduction to the research being done, as well as a roadmap for the layout of this thesis. Chapter II described the DRIVE model and how its algorithm works. Chapter III consisted of a review of previous research on DRIVE, as well as information about UMMIPS. Chapter IV illustrated the methodology used for this research. Chapter V showed the results of the six different research levels in terms of the research questions

and hypotheses. Finally, this chapter discussed conclusions based on the research results, as well as implications for the Air Force. This research looked at current approaches of distributing reparable assets, but does not address where they should be stocked (at the depot or the base). The results of this research are consistent with previous research results in that DRIVE implementation seems to be an improvement over UMMIPS for asset distribution.

Appendix A. List of Acronyms and Abbreviations

AA	Aircraft Availability
AB	Air Base
AFB	Air Force Base
AFM	Air Force Manual
AFIT	Air Force Institute of Technology
AFLC	Air Force Logistics Command (AFMC predecessor)
AFMC	Air Force Materiel Command
ALC	Air Logistics Center
AWP	Awaiting Parts
BLSS	Base-Level Self-Sufficiency Spares
CDF	Cumulative Distribution Function
CONOPS	Concept of Operations
CONUS	Continental United States
D035	AFMC's Stock Control and Distribution System
D035A	A Subsystem of D035 for Awaiting Parts (AWP) Data
D035C	A Subsystem of D035 for Serviceable Asset Data
D035K	A Subsystem of D035 for Depot Serviceable Asset Data
D087J	WSMIS Classified DRIVE Module
D087K	WSMIS Unclassified DRIVE Module
DDM	DRIVE Distribution Module
Dep Rep Gens	Depot Reparable Generations
DIFM	Due-In From Maintenance
DMSC	Depot Maintenance Supply Center
DRIVE	Distribution and Repair in Variable Environments
ENMCS	Expected Not-Mission Capable - Supply
ES	Equipment Specialist

EXPRESS	Execution and Prioritization of Repair Support System
FAD	Force Activity Designator
FAP	Item Application Percent
FMS	Foreign Military Sales
G402A	AFMC System for Awaiting Parts (AWP) Data
HQ USAF/LGSP	Headquarters United States Air Force, Supply Procedures
IM	Item Manager
JCS	Joint Chiefs of Staff
LL	Lean Logistics
LMI	Logistics Management Institute
LRU	Line-Replaceable Unit
MAJCOM	Major Command
MDS	Mission-Design-Series
MICAP	Mission Capable
MOA	Memorandum of Agreement
MRSP	Mobility Readiness Spares Package
NMCS	Non-Mission Capable - Supply
NRTS	Not Repairable This Station
NSN	National Stock Number
OCONUS	Overseas
OST	Order and Ship Time
PAA	Primary Assigned Aircraft
PBR	Percent Base Repair
POS	Primary Operating Stock
QPA	Quantity Per Application
RR	Remove and Replace
RRC	Regional Repair Center
SAM	Sustainability Assessment Model (part of WSMIS)
SIT	Serviceable In-Transit

SPM	System Program Manager
SRAN	Stock Record Account Number
SRU	Shop-Replaceable Unit
TRADES	Theater Repair and Distribution Executive System
UMD	Urgency of Need Designator
UMMIPS	Uniform Material Movement and Issue Priority System
VTMR	Variance-To-Mean Ratio
WRM	War Reserve Material
WRSK	War Readiness Spares Kit
WSMIS	Weapon System Management Information System

Appendix B. The DRIVE Objective Function

The DRIVE objective function computes the probability that a base will meet its availability goal at the end of a planning horizon for an LRU family. The approach is to determine the number of LRU failures the base can experience during the planning horizon without preventing it from meeting its availability goal, then the likelihood of not exceeding that amount of failures is computed. The input data required needed for the computation are the same as shown for the intermediate calculations:

1) Stock
2) Holes
3) QPA
4) Expected NRTS
5) Allowable Holes

The probability that a base will meet its availability goal at the end of the planning horizon is the probability that it experiences less than or equal to "F" failures, where "F" equals the allowable holes for an LRU plus its stock. This can be expressed as:

$$BP = \sum_{x=0}^{F} FBx$$

where BP = the probability that a base will meet its availability goal at the end of the planning horizon due to this LRU

F = allowable demands, which is the sum of allowable holes and stock; it is the number of demands (failures) that are allowed to occur for the LRU at the base during the planning horizon without preventing the base from meeting its availability goal

FBx = the probability that the LRU will experience x failures at the base during the planning horizon

Actual LRU failures result in NRTS actions, base repair actions that result in AWP, and base repair actions that don't result in AWP. Since the base does not need any support from the depot for the base repair actions that don't result in AWP, DRIVE does not consider these failures. It only looks at failures that generate NRTS, condemnations, and AWP. So, the failure probability can be expressed as:

$$FBx = \sum_{y=0}^{x} GP_y * BP_{x\text{-}y}$$

where, GP_y = the probability that y LRU NRTS will generate from this base during the planning horizon
$BP_{x\text{-}y}$ = the probability that (x-y) LRU base AWP will generate from this base during the planning horizon

This formula introduces two probability distributions to the computation of the DRIVE objective function, GP and BP.

GP - LRU NRTS Probability Distribution

This is a distribution that reflects the probability that a given number of LRU NRTS will occur at the base during the planning horizon. It is computed using the expected NRTS for the LRU (discussed above) and assuming a negative binomial probability distribution. The "shape" of the distribution is determined using the Sherbrooke regression formula for the variance-to-mean ratio (VTMR):

VTMR • 1.0001 + .14 x (expected yearly NRTS)**0.5
(note: ** symbolizes exponent)

For example, if the LRU has an expected NRTS quantity of 4 during a 14 day planning horizon, the VTMR would be 2.26 and the probability distribution for the LRU NRTS during the planning horizon would be as shown in the following bar chart.

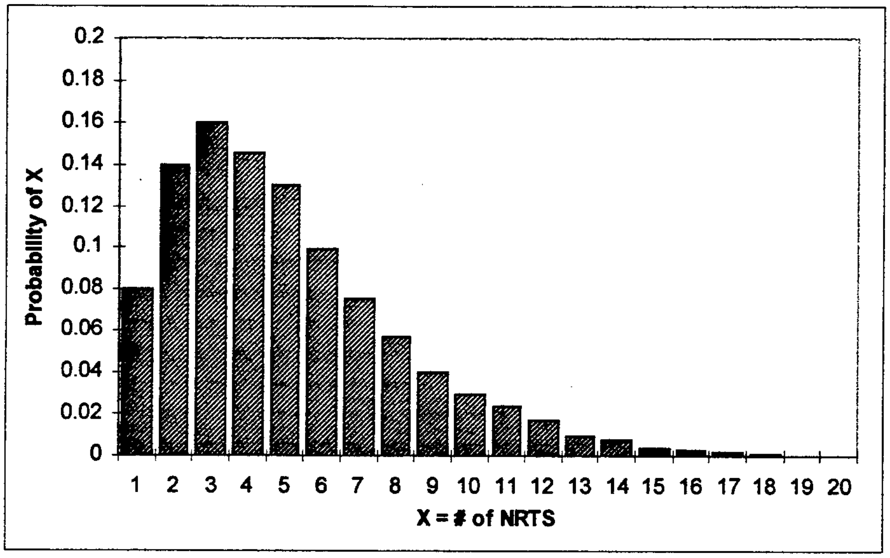

Figure B-1. LRU NRTS Distribution

Note that even though the expected NRTS quantity is 4, there is still a slim chance that as many as 18 NRTS will occur. The purpose of the probability distribution is to capture the uncertainty of future NRTS.

BP - LRU base AWP probability distribution

BP reflects the probability that a given number of additional base AWP LRUs (beyond those already AWP) will generate from a base during the planning horizon. This probability distribution is most easily derived by considering the cumulative distribution

function (CDF) of the BP distribution, which reflects the probability that less than or equal to a given number of additional base AWP LRUs will fail at a base during the planning horizon:

$$BP_x = CumBP_x - CumBP_{x-1}\ ,\ x=1,2,3,...$$
$$BP_0 = CumBP_0$$

where, $CumBP_x$ = the CDF of BP

CumBP is ultimately derived from the NRTS distributions of the SRUs. In other words, when an SRU is NRTS'd it must be because an LRU has failed and was able to be repaired at the base. Crucial to the computation of CumBP is the assumption that SRUs will be fully cannibalized across broken LRUs to minimize the number of AWP LRUs, or, equivalently, to concentrate the most SRU holes in the fewest number of broken LRUs.

For example, consider an LRU with 2 SRUs. SRU 1 has 3 holes and a QPA of 2 while SRU 2 has 1 hole and a QPA of 1. In a worst case scenario, the SRU failures could have occurred as shown in Figure 2 below:

	broken LRU	broken LRU	broken LRU	broken LRU
SRU 1	X O	X O	X O	O O
SRU 2	O	O	O	X

(X - broken SRU O - serviceable SRU)

Figure B-2. Before Cannibalization of SRUs

Note in this case there are 4 AWP (awaiting parts) LRUs. DRIVE assumes that the base fully cannibalizes SRUs so that there are only 2 AWP LRUs and 2 serviceable LRUs. The picture after cannibalization is as follows:

	broken LRU	broken LRU	broken LRU	broken LRU
SRU 1	X X	X O	O O	O O
SRU 2	X	O	O	O

(X - broken SRU O - serviceable SRU)

Figure B-3. After Cannibalization of SRUs

The computation of CumBP is done by considering the effect of each SRU as follows:

$$CumBP_x = \prod_{s=1}^{NS} CumSP_{s,x}$$

where, NS = the number of SRUs on the LRU
$CumSP_{s,x}$ = the probability that SRUs will cause less than or equal to x additional LRUs to be AWP

Note that this formula implicitly assumes that the different types of SRUs are cannibalized across LRUs. Consider the example of an LRU with 2 SRUs. SRU 1 has a 20% probability of causing less than or equal to 3 additional AWP LRUs, meaning that there is a 20% chance that 0, 1, 2, or 3 additional LRUs will be AWP if only SRU 1 were to experience failures. SRU 2 has a 30% probability of causing less than or equal to 3 additional AWP LRUs and a similar interpretation. When considering both SRU 1 and SRU 2 failures and cannibalization, there will be 3 additional AWP LRUs if there is any

combination of 0, 1, 2, or 3 additional AWP LRUs from SRU 1 failures and 0, 1, 2, or 3 additional AWP LRUs from SRU 2 failures. The probability of this happening is simply 20% x 30% = 6%.

The computation of CumSP is made for each SRU indentured to the LRU. It also uses the cannibalization assumption by suggesting that a given type of SRU is fully cannibalized to minimize the number of AWP LRUs. Cannibalization within a given type of SRU is only possible when the SRU's QPA on the LRU is greater than 1. Important to the computation of CumSP is the number of LRUs AWP at the start of the planning horizon and how many holes each type of SRU is causing in those LRUs. Recall that we are interested in the number of additional LRUs that will be AWP. If there are 10 AWP LRUs at the start of the planning horizon (after cannibalization) and an SRU has a QPA of 2, the SRU can cause 20 holes in the LRU without causing any additional LRUs to be AWP. If the SRU is initially causing 7 holes, it can have 13 additional failures without causing any additional LRUs to be AWP. This is because any LRUs that enter base repair due to SRU 1 failures can be made serviceable by cannibalizing from the 13 'good' SRUs in the initial 10 AWP LRUs. The formula for CumSP is:

$$CumSP_{s,x} = \sum_{i=0}^{SF_{s,x}} GP_{s,x}$$

where, $SF_{s,x}$ = the number of NRTS that can occur for SRUs without causing more than x additional LRUs to be AWP

$GP_{s,x}$ = the probability that SRU s will generate x NRTS from this base during the planning horizon

The formula for SF is:

$$SF_{s,x} = (LA + x) * QPA_S + SS_S - HS_S$$

where, LA = the beginning number of LRUs AWP

QPA_S = the QPA of SRUs on the LRU

SS_S = the number of serviceable SRUs at the base

HS_S = the number of holes SRUs is causing at the base

GP is computed the same for SRUs as it was for LRUs.

Appendix C. Research SRANs

	SRAN	BASE
AF Bases	FB2500	Peterson
	FB2823	Eglin Aux Fld3
	FB3010	Keesler
	FB3300	Maxwell
	FB4417	Hurlburt
	FB4460	Little Rock
	FB4469	Kirtland
	FB4661	Dyess
	FB4810	Howard
	FB4877	Davis-Monthan
	FB5000	Elmendorf
	FB5209	Yokota
	FB5518	RAF Mildenhall
ANG Bases	FB6081	Wilmington, DE
	FB6102	Savannah, GA
	FB6161	Standiford, KY
	FB6252	Rosecrans, MO
	FB6323	Schenectady, NY
	FB6331	Douglas, NC
	FB6353	Mansfield, OH
	FB6421	Nashville, TN
	FB6431	Dallas, TX
	FB6481	Yeager, WV
	FB6501	Cheyenne, WY
	FB6520	Kullis, AK
	FB6530	Hickam, HI
	FB6562	Will Rogers, OK
AFR Bases	FB6605	Billy Mitchell
	FB6618	OHare
	FB6656	Youngstown
	FB6670	Niagra Falls
	FB6703	Dobbins
	FB6712	Pittsburgh

Appendix D. Allocations of Available Assets

	Level 1		Level 2		Level 3		Levels 4&5		Level 6	
NSN	SRAN	#	SRAN	#	SRAN	#	SRAN	#	SRAN	#
1610013184870	FB2823	16	FB2823	16	FB2500	1	FB2500	1	FB2500	1
	FB3010	2	FB3010	3	FB2823	3	FB2823	3	FB2823	3
	FB4417	44	FB4417	44	FB3010	5	FB3010	5	FB3010	5
	FB4661	2	FB4469	2	FB3300	1	FB3300	1	FB3300	1
	FB4877	2	FB4661	1	FB4417	2	FB4417	3	FB4417	3
	FB5000	1	FB4877	3	FB4460	6	FB4460	6	FB4460	6
	FB5209	1	FB5000	1	FB4469	4	FB4469	4	FB4469	4
	FB5518	5	FB5209	1	FB4661	11	FB4661	11	FB4661	12
	FB6081	1	FB5518	5	FB4877	6	FB4877	6	FB4877	6
	FB6252	4	FB6081	2	FB5000	1	FB5000	1	FB5000	1
	FB6421	1	FB6102	1	FB5209	3	FB5209	4	FB5209	4
	FB6431	2	FB6252	1	FB6081	2	FB6081	2	FB6081	2
	FB6520	1	FB6421	1	FB6102	1	FB6252	4	FB6252	4
	FB6530	1	FB6431	2	FB6252	4	FB6323	4	FB6323	3
	FB6562	2	FB6520	1	FB6323	4	FB6331	3	FB6331	3
	FB6703	1	FB6530	1	FB6331	3	FB6353	3	FB6353	3
	FB6712	3	FB6703	1	FB6353	3	FB6421	3	FB6421	3
			FB6712	3	FB6421	3	FB6431	2	FB6431	2
					FB6431	2	FB6481	1	FB6481	1
					FB6481	1	FB6501	2	FB6501	2
					FB6501	2	FB6520	3	FB6520	3
					FB6520	3	FB6562	3	FB6562	3
					FB6530	1	FB6605	3	FB6605	3
					FB6562	3	FB6656	5	FB6656	5
					FB6605	3	FB6670	1	FB6670	1
					FB6656	5	FB6703	2	FB6703	2
					FB6670	1	FB6712	3	FB6712	3
					FB6703	2				
					FB6712	3				
Total		89		89		89		89		89
1660000620301	FB2823	7	FB2500	2	FB2500	3	FB2500	3	FB2500	3
	FB3010	6	FB2823	5	FB3010	4	FB3010	4	FB3010	4
	FB3300	5	FB3010	3	FB3300	4	FB3300	4	FB3300	4
	FB4417	13	FB3300	3	FB4460	28	FB4460	28	FB4460	28
	FB4460	20	FB4417	13	FB4469	4	FB4469	4	FB4469	4
	FB4661	7	FB4460	26	FB4661	13	FB4661	13	FB4661	12
	FB4877	10	FB4469	3	FB4810	2	FB4810	2	FB4810	2
	FB5000	3	FB4661	12	FB4877	5	FB4877	5	FB4877	5
	FB5209	7	FB4810	1	FB5000	4	FB5000	4	FB5000	4
	FB5518	1	FB4877	5	FB5209	4	FB5209	4	FB5209	4
	FB6081	3	FB5000	3	FB6081	4	FB6081	4	FB6081	4

	FB6102	4	FB5209	3	FB6102	4	FB6102	4	FB6102	4
	FB6161	3	FB5518	1	FB6161	3	FB6161	3	FB6161	3
	FB6252	2	FB6081	3	FB6252	3	FB6252	3	FB6252	3
	FB6323	6	FB6102	3	FB6323	2	FB6323	2	FB6323	2
	FB6331	4	FB6161	2	FB6331	5	FB6331	5	FB6331	4
	FB6353	3	FB6252	2	FB6353	4	FB6353	4	FB6353	4
	FB6421	3	FB6323	1	FB6421	2	FB6421	2	FB6421	2
	FB6431	5	FB6331	5	FB6431	4	FB6431	4	FB6431	4
	FB6481	4	FB6353	3	FB6481	4	FB6481	4	FB6481	4
	FB6501	1	FB6421	2	FB6501	4	FB6501	4	FB6501	4
	FB6520	2	FB6431	3	FB6520	4	FB6520	4	FB6520	4
	FB6530	1	FB6481	3	FB6530	1	FB6530	1	FB6530	1
	FB6562	3	FB6501	3	FB6562	3	FB6562	3	FB6562	4
	FB6605	3	FB6520	4	FB6605	3	FB6605	3	FB6605	3
	FB6656	4	FB6530	1	FB6618	3	FB6618	3	FB6618	3
	FB6703	4	FB6562	3	FB6656	5	FB6656	5	FB6656	5
	FB6712	1	FB6605	3	FB6703	3	FB6703	3	FB6703	4
			FB6618	3	FB6712	3	FB6712	3	FB6712	3
			FB6656	5						
			FB6703	3						
			FB6712	3						
Total		135		135		135		135		135
1660003434692	FB2500	2	FB2500	2	FB2500	3	FB2500	3	FB2500	3
	FB2823	3	FB2823	3	FB3010	2	FB3010	2	FB3010	2
	FB3010	7	FB3010	2	FB3300	2	FB3300	2	FB3300	2
	FB3300	2	FB3300	2	FB4460	17	FB4460	17	FB4460	17
	FB4417	4	FB4417	4	FB4469	3	FB4469	3	FB4469	3
	FB4460	11	FB4460	16	FB4661	7	FB4661	7	FB4661	7
	FB4661	4	FB4469	3	FB4877	2	FB4877	2	FB4877	2
	FB4810	2	FB4661	7	FB5000	2	FB5000	2	FB5000	2
	FB4877	2	FB4877	2	FB6081	1	FB6081	1	FB6081	1
	FB5000	2	FB5000	2	FB6102	1	FB6102	1	FB6102	1
	FB5209	2	FB6081	1	FB6161	2	FB6161	2	FB6161	2
	FB6081	1	FB6102	1	FB6252	1	FB6252	1	FB6252	1
	FB6102	1	FB6161	2	FB6331	1	FB6331	1	FB6331	1
	FB6161	1	FB6252	1	FB6353	2	FB6353	2	FB6353	2
	FB6252	2	FB6331	1	FB6421	2	FB6421	2	FB6421	2
	FB6323	2	FB6353	2	FB6431	2	FB6431	2	FB6431	2
	FB6421	1	FB6421	2	FB6481	2	FB6481	2	FB6481	2
	FB6431	2	FB6431	2	FB6520	2	FB6520	2	FB6520	2
	FB6481	4	FB6481	2	FB6562	2	FB6562	2	FB6562	2
	FB6520	1	FB6520	2	FB6605	2	FB6605	2	FB6605	2
	FB6530	1	FB6562	1	FB6618	2	FB6618	2	FB6618	2
	FB6562	3	FB6605	1	FB6656	4	FB6656	4	FB6656	4
	FB6605	2	FB6618	1	FB6703	1	FB6703	1	FB6703	1
	FB6618	3	FB6656	4	FB6712	3	FB6712	3	FB6712	3

	FB6656	1	FB6712	2						
	FB6703	1								
	FB6712	1								
Total		68		68		68		68		68
6615010657226	FB2823	9	FB2500	5	FB2500	6	FB2500	6	FB2500	6
	FB3010	10	FB2823	5	FB3010	3	FB3010	3	FB3010	3
	FB3300	1	FB3010	2	FB3300	1	FB3300	1	FB3300	1
	FB4417	31	FB4417	31	FB4417	6	FB4417	6	FB4417	6
	FB4460	7	FB4460	12	FB4460	14	FB4460	14	FB4460	14
	FB4661	23	FB4469	2	FB4469	3	FB4469	3	FB4469	3
	FB4877	5	FB4661	19	FB4661	22	FB4661	22	FB4661	22
	FB5000	3	FB4810	1	FB4810	2	FB4810	2	FB4810	2
	FB5518	6	FB4877	8	FB4877	9	FB4877	9	FB4877	9
	FB6081	6	FB5000	3	FB5000	4	FB5000	4	FB5000	4
	FB6102	3	FB5209	5	FB5209	6	FB5209	6	FB5209	6
	FB6161	3	FB5518	6	FB6081	6	FB6081	6	FB6081	6
	FB6252	3	FB6081	5	FB6102	3	FB6102	3	FB6102	3
	FB6323	9	FB6102	2	FB6161	4	FB6161	5	FB6161	5
	FB6421	2	FB6161	3	FB6252	6	FB6252	6	FB6252	6
	FB6431	1	FB6252	5	FB6323	1	FB6331	8	FB6331	8
	FB6481	2	FB6323	1	FB6331	8	FB6353	6	FB6353	6
	FB6501	7	FB6331	7	FB6353	6	FB6421	6	FB6421	6
	FB6520	9	FB6353	5	FB6421	6	FB6431	6	FB6431	6
	FB6530	1	FB6421	5	FB6431	6	FB6501	4	FB6501	4
	FB6562	3	FB6431	5	FB6501	4	FB6520	4	FB6520	4
	FB6605	3	FB6501	3	FB6520	4	FB6530	2	FB6530	2
	FB6618	2	FB6520	2	FB6530	2	FB6562	5	FB6562	5
	FB6656	12	FB6530	1	FB6562	5	FB6605	6	FB6605	6
	FB6670	7	FB6562	4	FB6605	6	FB6618	6	FB6618	6
	FB6703	3	FB6605	4	FB6618	6	FB6656	8	FB6656	8
	FB6712	3	FB6618	4	FB6656	8	FB6670	6	FB6670	6
			FB6656	7	FB6670	6	FB6703	6	FB6703	6
			FB6670	4	FB6703	6	FB6712	5	FB6712	5
			FB6703	4	FB6712	5				
			FB6712	4						
Total		174		174		174		174		174
4810006122696HS	FB3300	1	FB4417	14	FB2500	1	FB2500	1	FB2500	1
	FB4417	14	FB4460	8	FB3300	1	FB3300	1	FB3300	1
	FB4469	1	FB4469	1	FB4460	11	FB4460	11	FB4460	11
	FB4661	1	FB4661	3	FB4469	2	FB4469	2	FB4469	2
	FB5518	6	FB5518	4	FB4661	4	FB4661	4	FB4661	4
	FB6331	1	FB6161	1	FB5518	1	FB5518	1	FB5518	1
	FB6431	1	FB6656	1	FB6161	2	FB6161	2	FB6161	2
	FB6481	2			FB6331	1	FB6331	1	FB6331	1
	FB6656	2			FB6353	1	FB6353	1	FB6353	1

	FB6670	1			FB6431	1	FB6431	1	FB6431	1
	FB6703	2			FB6481	1	FB6481	1	FB6481	1
					FB6501	1	FB6501	1	FB6501	1
					FB6562	1	FB6562	1	FB6562	1
					FB6656	2	FB6656	2	FB6656	2
					FB6703	1	FB6703	1	FB6703	1
					FB6712	1	FB6712	1	FB6712	1
Total		32		32		32		32		32
4810010390459TP	FB4417	8	FB4417	8	FB4460	1	FB4460	1	FB4460	1
					FB4661	2	FB4661	2	FB4661	2
					FB6081	1	FB6081	1	FB6081	1
					FB6161	1	FB6252	1	FB6252	1
					FB6252	1	FB6353	1	FB6353	1
					FB6353	1	FB6431	1	FB6431	1
					FB6431	1	FB6656	1	FB6656	1
Total		8		8		8		8		8

Appendix E. Change and Range Between Research Levels

	Day	182					Day	210				
	L1	L2	L3	L4&5	L6		L1	L2	L3	L4&5	L6	
Base	%	%	%	%	%		%	%	%	%	%	
name	FMC	FMC	FMC	FMC	FMC	range	FMC	FMC	FMC	FMC	FMC	range
---	---	---	---	---	---	---	---	---	---	---	---	---
2500	78	91	95	95	95	17	70	83	87	87	87	17
change	n/a	13	4	0	0		n/a	13	4	0	0	
2823	96	96	95	95	95	1	90	90	89	89	89	1
	n/a	0	-1	0	0		n/a	0	-1	0	0	
3010	95	95	97	97	97	2	87	83	89	89	89	6
	n/a	0	2	0	0		n/a	-4	6	0	0	
3300	89	86	89	89	89	3	83	79	83	83	83	4
	n/a	-3	3	0	0		n/a	-4	4	0	0	
4417	100	100	100	100	100	0	100	100	99	99	99	1
	n/a	0	0	0	0		n/a	0	-1	0	0	
4460	90	96	97	97	97	7	81	90	92	92	92	11
	n/a	6	1	0	0		n/a	9	2	0	0	
4469	51	74	82	82	82	31	100	100	100	100	100	0
	n/a	23	8	0	0		n/a	0	0	0	0	
4661	91	93	97	97	97	6	76	81	87	87	87	11
	n/a	2	4	0	0		n/a	5	6	0	0	
4810	100	100	100	100	100	0	100	100	100	100	100	0
	n/a	0	0	0	0		n/a	0	0	0	0	
4877	87	91	95	95	95	8	81	86	90	90	90	9
	n/a	4	4	0	0		n/a	5	4	0	0	
5000	92	92	92	92	92	0	85	85	86	86	86	1
	n/a	0	0	0	0		n/a	0	1	0	0	
5209	85	93	94	94	94	9	77	86	88	88	88	11
	n/a	8	1	0	0		n/a	9	2	0	0	
5518	100	100	99	99	99	1	100	100	98	98	98	2
	n/a	0	-1	0	0		n/a	0	-2	0	0	
6081	88	89	94	94	94	6	82	82	88	88	88	6
	n/a	1	5	0	0		n/a	0	6	0	0	
6102	96	96	97	96	96	1	91	89	92	91	91	3
	n/a	0	1	-1	0		n/a	-2	3	-1	0	
6161	88	91	96	92	92	8	75	80	88	83	83	13
	n/a	3	5	-4	0		n/a	5	8	-5	0	
6252	87	85	94	94	94	9	80	79	88	88	88	9
	n/a	-2	9	0	0		n/a	-1	9	0	0	
6323	88	87	96	95	95	9	85	83	91	90	89	8
	n/a	-1	9	-1	0		n/a	-2	8	-1	-1	
6331	80	90	91	91	91	11	71	84	86	86	85	15
	n/a	10	1	0	0		n/a	13	2	0	-1	

6353	74	84	**94**	**94**	**94**	20	65	78	**88**	**88**	**88**	23
	n/a	**10**	**10**	0	0		n/a	**13**	10	0	0	
6421	88	**91**	**91**	**91**	**91**	3	80	84	**85**	**85**	**85**	5
	n/a	**3**	0	0	0		n/a	**4**	1	0	0	
6431	82	86	**94**	**94**	**94**	12	73	80	**88**	**88**	**88**	15
	n/a	4	**8**	0	0		n/a	7	**8**	0	0	
6481	**95**	89	94	94	94	6	**90**	83	88	88	88	7
	n/a	**-6**	5	0	0		n/a	**-7**	5	0	0	
6501	85	88	**95**	**95**	**95**	10	78	82	**89**	**89**	**89**	11
	n/a	3	**7**	0	0		n/a	4	**7**	0	0	
6520	86	89	**91**	**91**	**91**	5	79	83	**86**	**86**	**86**	7
	n/a	**3**	2	0	0		n/a	**4**	3	0	0	
6530	**90**	82	84	83	83	8	**82**	71	76	73	73	11
	n/a	**-8**	2	-1	0		n/a	**-11**	5	-3	0	
6562	88	84	**94**	**94**	**94**	10	82	79	87	87	**88**	9
	n/a	-4	**10**	0	0		n/a	-3	**8**	0	1	
6605	84	84	**89**	**89**	**89**	5	78	77	**83**	**83**	**83**	6
	n/a	0	**5**	0	0		n/a	-1	**6**	0	0	
6618	82	90	**92**	**92**	**92**	10	73	82	**85**	**85**	**85**	12
	n/a	**8**	2	0	0		n/a	**9**	3	0	0	
6656	87	89	92	**95**	**95**	8	68	74	78	**85**	**85**	17
	n/a	2	**3**	**3**	0		n/a	6	4	**7**	0	
6670	93	92	**94**	**94**	**94**	2	**87**	84	**87**	**87**	**87**	3
	n/a	-1	**2**	0	0		n/a	**-3**	**3**	0	0	
6703	87	84	**89**	**89**	**89**	5	80	77	**83**	**83**	**83**	6
	n/a	-3	**5**	0	0		n/a	-3	**6**	0	0	
6712	82	86	**90**	**90**	**90**	8	75	81	**85**	**85**	**85**	10
	n/a	**4**	**4**	0	0		n/a	**6**	4	0	0	

Appendix F. Frequency and Range of Values Within Each Level

Day	L1		L2		L3		L4&5		L6	
182	%		%		%		%		%	
	FMC	freq.	FMC	freq.	FMC	freq.	FMC	freq.	FMC	freq.
	---		---		---		---		---	
	100	3	100	3	100	2	100	2	100	2
	96	2	96	3	99	1	99	1	99	1
	95	2	95	1	97	4	97	3	97	3
	93	1	93	2	96	2	96	1	96	1
	92	1	92	2	95	4	95	6	95	6
	91	1	91	4	94	8	94	8	94	8
	90	2	90	2	92	3	92	3	92	3
	89	1	89	4	91	3	91	3	91	3
	88	5	88	1	90	1	90	1	90	1
	87	4	87	1	89	3	89	3	89	3
	86	1	86	3	84	1	83	1	83	1
	85	2	85	1	82	1	82	1	82	1
	84	1	84	4						
	82	3	82	1						
	80	1	74	1						
	78	1								
	74	1								
	51	1								
range	49		26		18		18		18	

Day	L1		L2		L3		L4&5		L6	
210	%		%		%		%		%	
	FMC	freq.	FMC	freq.	FMC	freq.	FMC	freq.	FMC	freq.
	---		---		---		---		---	
	100	4	100	4	100	2	100	2	100	2
	91	1	90	2	99	1	99	1	99	1
	90	2	89	1	98	1	98	1	98	1
	87	2	86	2	92	2	92	1	92	1
	85	2	85	1	91	1	91	1	91	1
	83	1	84	3	90	1	90	2	90	1
	82	3	83	5	89	3	89	3	89	4
	81	2	82	3	88	7	88	6	88	7
	80	3	81	2	87	4	87	4	87	3
	79	1	80	2	86	3	86	3	86	2
	78	2	79	3	85	3	85	4	85	5
	77	1	78	1	83	3	83	4	83	4
	76	1	77	2	78	1	73	1	73	1
	75	2	74	1	76	1				

	73	2	71	1						
	71	1								
	70	1								
	68	1								
	65	1								
range	35		29		24		27		27	

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11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 Words)*

This study explores different levels of DRIVE implementation in proposed asset release policies to help clarify which policy could best support Air Force weapon systems. The research used the Uniform Material Movement and Issue Priority System (UMMIPS) as a baseline for comparison with five levels of DRIVE implementation. The results yielded evidence that DRIVE utilization increases both overall aircraft availability and availability for bases with a FAD of two, while FAD one locations saw only a marginal decline in availability rates. Although greater DRIVE implementation than current policy did not yield better results, pure DRIVE utilization performed as well as current operating policy, and better than UMMIPS logic. The research results provided evidence that the latest HQ USAF/LGSP proposed asset distribution policy would produce worse results than current operating policy. DRIVE's asset distribution decisions produced the best overall results within the scope of this research, and warrant further study for even greater understanding of DRIVE's capabilities and limitations.

14. SUBJECT TERMS
Distribution and Repair in Variable Environments, DRIVE, Reparable Asset Distribution, MICAP Release Sequence, UMMIPS, Aircraft Availability

15. NUMBER OF PAGES
117

16. PRICE CODE

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AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. **Please return completed questionnaire** to: AIR FORCE INSTITUTE OF TECHNOLOGY/LAC, 2950 P STREET, WRIGHT-PATTERSON AFB OH 45433-7765. Your response is **important.** Thank you.

1. Did this research contribute to a current research project? a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

   a. Yes b. No

3. **Please estimate** what this research would have cost in terms of manpower and dollars if it had been accomplished under contract or if it had been done in-house.

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4. Whether or not you were able to establish an equivalent value for this research (in Question 3), what is your estimate of its significance?

   a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

5. Comments (Please feel free to use a separate sheet for more detailed answers and include it with this form):

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